RESPIRONICS®
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Pressure Alarm Service Manual

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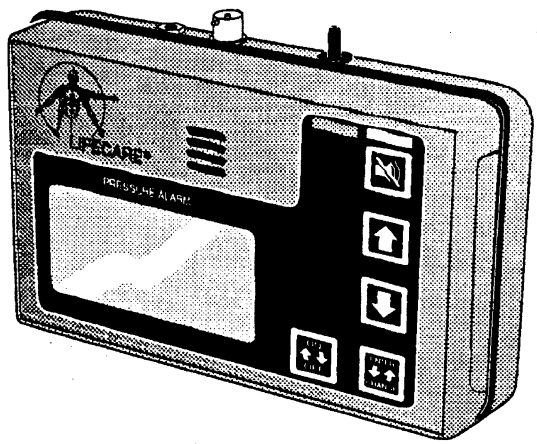
Pressure Alarm



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Introduction

Section 1.0

About this Manual
Servicing and Warranty
Service Location
Service and Inspection Forms
Equipment Inspection
Test Equipment and Tools
Service Guidelines

About this Manual

▼ This manual is intended for use when servicing the LIFECARE® Pressure Alarm. Sections covering troubleshooting, operational checks, and testing are included. Personnel servicing the Pressure Alarm should be thoroughly familiar with the Pressure Alarm Operating Manual and the Pressure Alarm's functions. Information contained within this document is subject to change without notice.

This manual is intended for persons trained in service, maintenance, and repair of modern medical equipment. Thorough knowledge of this equipment's operation is required before attempting to repair this equipment. Please read the entire service manual before attempting to repair this equipment.

This procedure is written for a technician experienced in volt meter usage, soldering, and electrical troubleshooting. **Do not attempt to repair the Pressure Alarm otherwise.** Unauthorized repair will void the warranty. Refer to the Pressure Alarm Operating Manual for complete warranty information.

A **WARNING** symbol is used when there is a possible hazard or danger to Service Personnel.

Servicing and Warranty

▼ It is recommended that the Pressure Alarm be serviced by an authorized LIFECARE Service Center once per year. This will allow LIFECARE Service Personnel to check the performance of the Pressure Alarm, recalibrate if necessary, and to check the electrical integrity of the entire unit.

LIFECARE warrants the Pressure Alarm to be free from defects in material and workmanship for a period of one year after delivery, provided that the unit is properly operated under conditions of normal use. LIFECARE will make replacements, repairs, or issue a credit for equipment or parts which are found to be defective. The defective unit may be returned prepaid to LIFECARE after the customer has received approval from LIFECARE to return the unit.

This warranty does not apply to any unit or individual parts which have been repaired or altered in a way that, in LIFECARE's judgement, affect its stability or reliability, or which has been subjected to misuse, negligence, abuse, or accident.

This warranty does not cover damage which may occur in shipment. If there is any damage in shipment, please contact the carrier or individual who delivered the unit.

Each customer is notified prior to the expiration of the original warranty period and is offered a free service check of each Pressure Alarm purchased. Each unit submitted for service is given complete Preventive Service and an Operational Check. In addition, each unit receives all mandatory engineering updates which have been approved for the unit, and any optional engineering updates upon customer request. The unit is then eligible for a maintenance contract upon completion of this service.

Introduction

Servicing and Warranty
Continued

LIFECARE offers a month-to-month maintenance contract on the Pressure Alarm. The maintenance contract covers all parts, labor, and loaner Pressure Alarms. If a unit is out of warranty, and a maintenance contract is desired, it is necessary for the owner to submit the unit to LIFECARE or a LIFECARE distributor for servicing, on a time and materials basis, to bring the unit in-line with LIFECARE standards. The unit can then be placed under a month-to-month maintenance contract.

LIFECARE® International, Inc. and LIFECARE® Europe have a policy of continued product improvement and reserve the right to alter specifications without notice.

Service Location

▼ The Pressure Alarm can be repaired at any LIFECARE Service Center located throughout most of the world.

WARNING: Federal law restricts this device to sale by or on the order of a physician.

Respironics
1001 Murry Ridge Lane
Murrysville, PA 15668
1-800-345-6443 or 724-387-4000

Equipment Inspection

▼ It is standard operating procedure for LIFECARE Distributors and District Offices to perform a final QA Inspection of the Pressure Alarm after servicing a unit or upon receipt of a new or remanufactured unit from the LIFECARE Home Office.

It is mandatory that all LIFECARE service personnel follow the QA Final Inspection for the Pressure Alarm before the unit is released to a client. These inspection guidelines provide a step-by-step procedure for documenting the results of tests performed on the operation of a Pressure Alarm.

Final QA Inspection performed on a Pressure Alarm includes such criteria as internal and external inspection, diagnostic check, and shipping configurations. The results, date and inspector's signature are recorded on each inspection form.

Any Pressure Alarm rejected during finished device inspection, and later reworked or remanufactured, must receive another complete QA Final Inspection.

Test Equipment and Tools

▼ The following equipment is required to service or repair the Pressure Alarm:

Test Equipment

98577 Fluke Meter
98589 Pressure Dump
98588 Digital Pressure Manometer (0.1% accuracy)
98187 Silicone Rubber Manostat Tubing, ¼" OD
35166 Tee, 1/8" ID
37146 Tie, Cable 5", Nylon

Standard Tools:

Phillips Head Screwdriver

Service Guidelines

▼ The decontamination procedure for returned equipment should be performed upon initial receipt of a Pressure Alarm from the client or hospital. This procedure should be completed before beginning service or handling the unit.

Before shipping a unit ensure a yellow sticky dot is placed on the unit to indicate that it has gone through the decontamination process. This dot must be removed at the next customer shipment or during repair.

If the Pressure Alarm **is not** being serviced due to a complaint, perform Operational Checks (Section 6.0). If the unit passes Operational Checks, perform Preventive Service, Run-In, Calibration, and testing. If the unit fails Operational Checks, perform the steps in Sections 7.0 through 11.0

Introduction

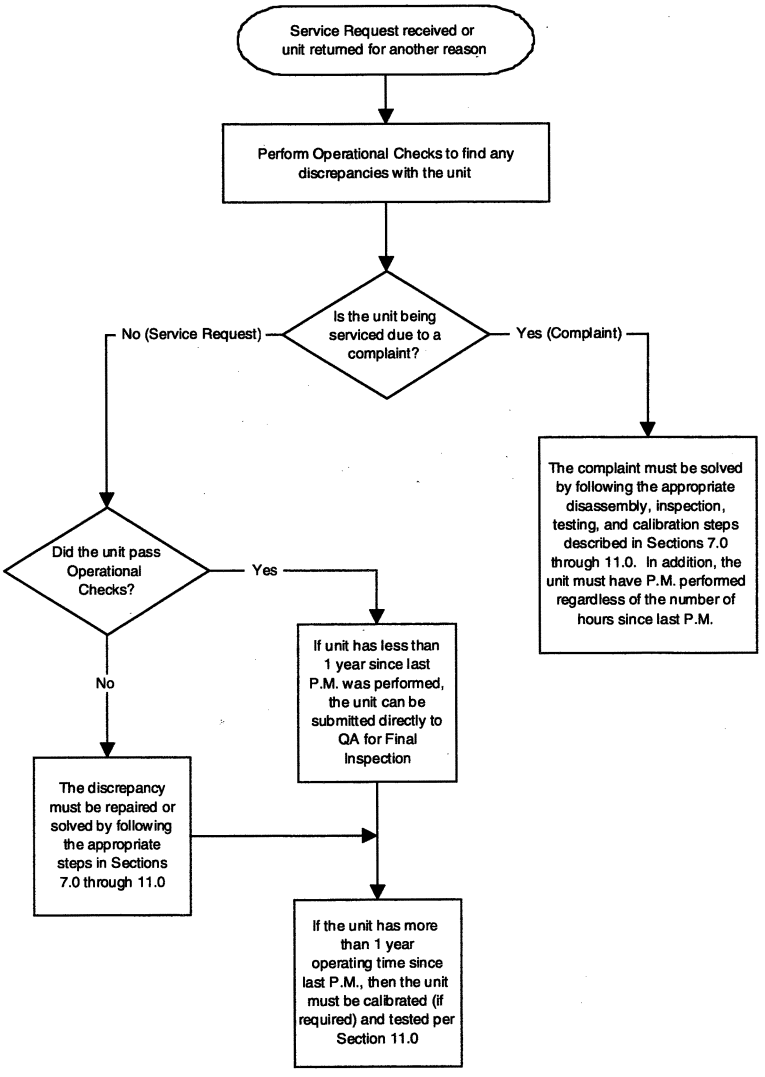
Service Guidelines
Continued

If the Pressure Alarm fails Operational Checks, perform Preventive Service, Disassembly, Inspection, and Reassembly, documenting work, Run-In and Calibration and testing.

NOTE: **DO NOT** change or replace the Preventive Service Due label if a Preventive Service is not performed. The date until next Preventive Service Due recorded on this label must be maintained for any future service required.

NOTE: A unit passes Operational Checks if no discrepancy is discovered in unit operation other than: minor voltage adjustments, or other minor repairs or adjustments that do not require the disassembly of the unit.

If the Pressure Alarm **is** being serviced due to a complaint, perform Operational Checks to find any other discrepancies with unit operation. The steps in Sections 5.0 through 11.0, including Preventive Service **MUST** also be performed, regardless of the date until next Preventive Service Due.


Service Request received or unit returned for another reason
Perform Operational Checks to find any discrepancies with the unit
Is the unit being serviced due to a complaint?
No (Service Request)
Yes (Complaint)
The complaint must be solved by following the appropriate disassembly, inspection, testing, and calibration steps described in Sections 7.0 through 11.0. In addition, the unit must have P.M. performed regardless of the number of hours since last P.M.
Did the unit pass Operational Checks?
Yes
No
If unit has less than 1 year since last P.M. was performed, the unit can be submitted directly to QA for Final Inspection
The discrepancy must be repaired or solved by following the appropriate steps in Sections 7.0 through 11.0
If the unit has more than 1 year operating time since last P.M., then the unit must be calibrated (if required) and tested per Section 11.0

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Warnings and Cautions

Section 2.0

Warnings and Cautions

▼ Periodically check and perform routine maintenance on the Pressure Alarm to insure proper operation.

DO NOT use the Pressure Alarm in the presence of flammable anesthetics.

DO NOT immerse the Pressure Alarm in any solution. DO NOT allow fluids or cleaning solutions to enter the alarm openings.

DO NOT steam autoclave.

REMOVE the battery BEFORE sterilization

Performance may be affected if the Pressure Alarm is operated outside the temperature range of 10°C to 40°C (50°F to 104°F).

DO NOT store the Pressure Alarm outside the temperature range of -10°C to 70°C (14°F to 158°F).

Alarms cannot be detected while the unit is in Set Mode (Set Mode turns off after 30 seconds of non-use).

When setting alarm values, if no value has been entered within 30 seconds the unit will return to the operation mode. While setting alarm values the Pressure Alarm cannot detect an alarm condition. Once the Pressure Alarm has been turned ON, all the alarm setting changes, including switch OFF, must be made in conjunction with the Enter/Change key. This feature is designed to prevent inadvertent setting changes.

Use the appropriate pressure source for the +100cm H_2O setting.

Specifications

Section 3.0

Adjustment Controls
Visual Indicators
Connection Jacks
Power Sources
Battery Life
Environmental Operating Ranges
Physical
Performance

Adjustment Controls

ON/OFF Key
Enter/Change Key
Arrow Keys
Alarm Silence Key

Visual Indicators

30 Second Alarm Silence LED	Yellow Indicator Light
Alarm LED	Red Indicator Light

LCD Display:

Positive Pressure Alarm Setting	0 to +99cm H_2O
Negative Pressure Alarm Setting	0 to -99cm H_2O
Alarm Delay Time Period	1 to 60 seconds
Peak Pressure Mode Indicator (In alarm delay window)	PP
Continuous Pressure Mode Indicator (In alarm delay window)	CP
Set/Off 'Time Out'	30 Seconds

Connection Jacks

DC Input Connector	Power Jack
Remote Alarm Cable Connector	Push and Twist BNC
Pressure Tubing Connector	3/16" OD

Power Sources

120 VAC to 9 VDC Converter
9 Volt Alkaline Battery

Battery Life

9 VDC Source
Approximately 2 weeks of continuous operating time (depending on alarms)

Environmental Operating Ranges

Operating Temperature	10°C to 40°C (50°F to 104°F)
Humidity Range	0 to 99% (non-condensing)
Allowable Effects on Accuracy	1cm H_2O or 3%, whichever is greater
Storage Temperature	-10°C to 70°C (14°F to 158°F)
Shelf Life	Indefinite with batteries removed
Cleaning/Sterilization Requirements	Clean with damp cloth. Sterilize using low temperature ethylene oxide.

Specifications

Physical

Overall Dimensions	16.3 X 9.4 X 3.8cm (6.4" X 3.7" X 1.5")
Weight	0.5Kg (1.1 lb.)
Materials of Construction	Injection Molded Plastic

Performance

Pressure Capabilities	Capable of sensing pressure in the range of -99 to +99 cm H_2O
Basic Accuracy*	1cm H_2O or 3% of reading, which ever is greater
Minimum Noise Level @ 1m	75dB
Spectrum Weighting	2.8 KHz ± 0.5 KHz

*Includes temperature range after re-zero, linearity, hysteresis, and repeatability, and state and operating range variability.

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Microprocessor
Continued

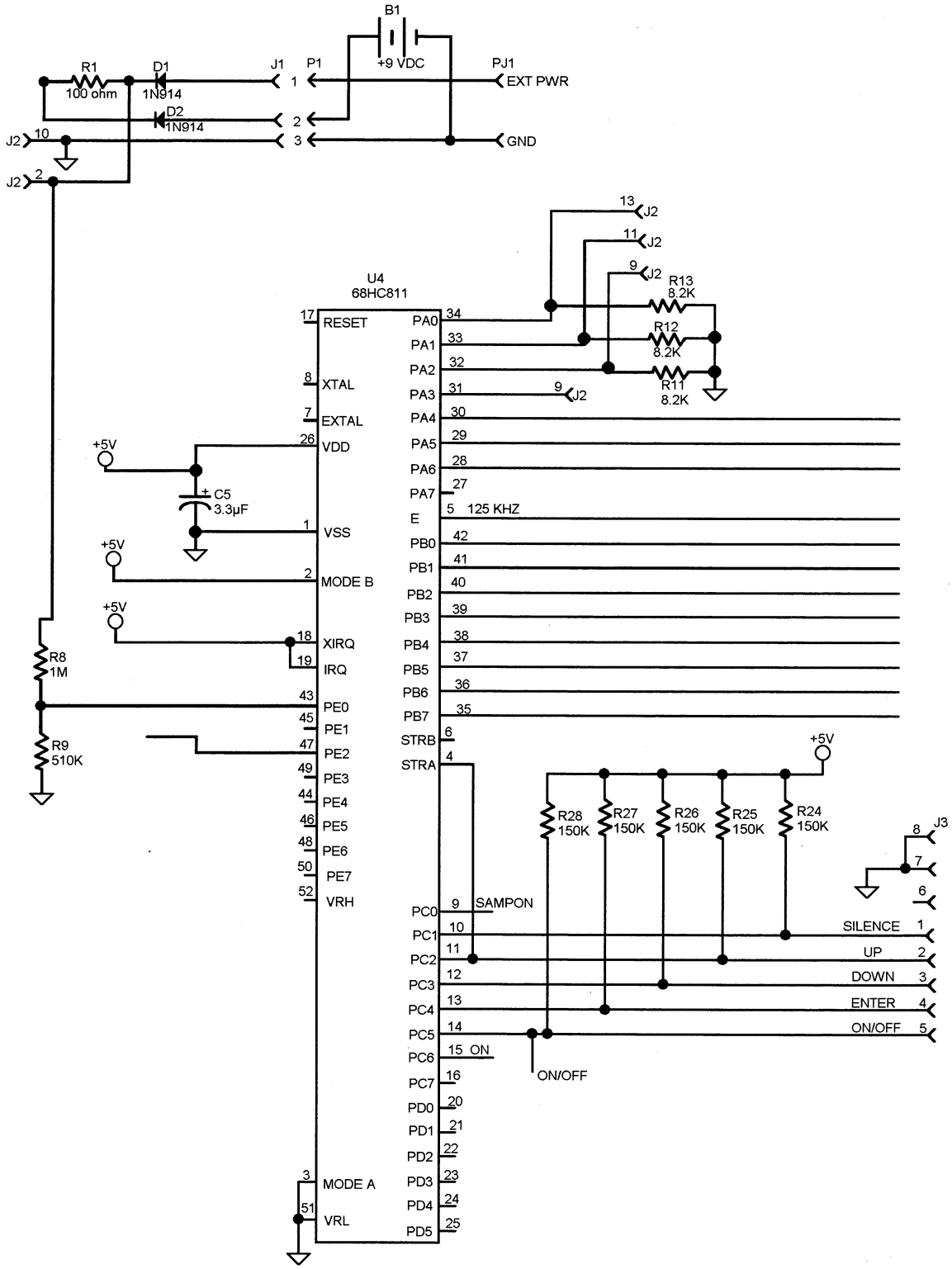

Figure 24 Microprocessor

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Troubleshooting **Section 4.0**

Problem	Diagnostic Check	Indication	Refer To
Unit Failure	• AC adaptor disconnected • Unit battery dead • Unit battery absent • Microprocessor chip damaged • Wiring harness failure	• Check to assure proper connection of AC adaptor • Check charge and condition of unit battery • Unit will alarm when battery power gets low • Replace microprocessor chip	
Horn Failure	• Software failure • Microprocessor failure • Power failure • Component failure or open circuit in electronics or wiring	• Failure of microprocessor, replace CPU • Check battery power • Unit will not beep upon initial power-on diagnostics	
LCD Data Misinterpretation	• Operator unfamiliar with alarm settings	• Check manual for correct data interpretation	Section 8.0 of Service Manual
Unintentional Settings Change	• Accidental keystrokes	• Check to assure settings require multiple keystrokes	
Pressure does not register	• Unit out of calibration • Port hole obstructed • Silicone rubber tubing loose	• Calibrate unit • Check port hole for obstruction or disconnection	Section 11.0 of Service Manual
Key(s) fail to pop into place	• Switch membrane damaged	• Replace switch membrane	Section 7.0 of Service Manual
Erroneous Signals	• Damaged Connectors or components	• Replace circuit board	
Incorrect Pressure Displayed	• Tubing damaged or not sealing port hole properly	• Reposition tubing on port hole or replace if damaged	

Preventive Maintenance **Section 5.0**

Preventive Maintenance

▼ Perform the following Preventive Service procedure each time a Pressure Alarm is serviced:

Run unit through start up and operational checks.

Check foot pads for wear and replace if necessary.

Check case for scratches or other cosmetic damage and replace if necessary.

Check switch membrane for scratches and other cosmetic damage and replace if necessary.

Press each key to ensure proper operation.

Test battery operation.

Test high and low pressure accuracy and calibrate unit if necessary.

Check tubing and wires for proper connections.

Perform the Quality Assurance Check-Out Procedure 23I-001.

Operational Checks

Section 6.0

Equipment Setup
Diagnostic Check
Operation Check
Visual Inspection
Unit Testing

Equipment Setup

▼ Cut the Silicone Rubber Manostat Tubing, (p/n 98187), into three 8" sections. Using the tee, (p/n 35166), attach one section of tubing to the pressure inlet on the Pressure Alarm unit, another to the Pressure Pump, (p/n 98589), and the remaining end to the Digital Pressure Manometer, (p/n 98588).

Diagnostic Check

▼ Turn the Pressure Alarm on by pressing the ON/OFF switch. The Pressure Alarm goes through a diagnostic check of the LCD, LEDs, audible and visual alarms, and the microprocessor, (the microprocessor goes through continual checks whenever the Pressure Alarm is operating).

The LCD displays all alpha characters and all eights in the numerical fields to confirm the integrity of the digital readouts.

The red LED and the yellow LED illuminate and the audible alarm sounds simultaneously for 0.5 seconds. This signals the end of the diagnostic check and confirms the integrity of the audible alarm. The unit displays the word "run" if the self check has passed.

NOTE: The software version number is displayed for 0.5 seconds before the word "run" is displayed in the unit window.

In case of an internal fault, the unit displays the word, "Err". The diagnostic check stops and the audible and visual alarms activate.

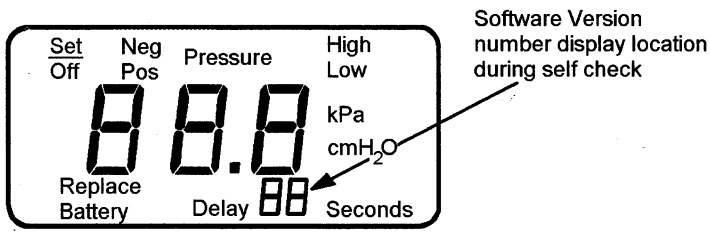

Figure 1 LCD Display During Diagnostic Check

Operational Checks

Operation Checks

▼ Operate unit with AC/DC converter plugged in. Whenever the power source changes from AC (9 volt DC Converter) to DC (internal battery), the Pressure Alarm sounds the audible alarm pulsed in groups of three, until intruppted by the operator, and flashes the word "Battery" on the LCD. The unit continues to operate normally when power source is switched to the internal battery. Cancel the alarm by pressing the Alarm Silence key.

Timing- Check the 30 second alarm time out by pressing the Alarm Silence key. The alarm must sound again after 30 seconds. Discrepancies in timing and alarm functions can be the result of the microprocessor clock not working.

Remote Alarm- If a Remote Alarm is attached to the Pressure Alarm, set the switch inside the battery compartment to "R.A." and check to see that it is functioning properly. Refer to Section 9.0, Hospital Alarm Interface.

Visual Inspection

▼ Check case for any visible damage and for correct fitting. Check screws for security. Replace any screws that are missing.

Unit Testing

▼ Measure the voltage of battery with voltmeter. A minimum 8.5 DC volts must be measured from the battery

Using the pressure pump and manometer, apply +99cm pressure to the unit. The reading from the Pressure Alarm must be within 2cm of the manometer reading. Apply -99cm pressure to the unit. The reading from the Pressure Alarm must be within 2cm of the manometer reading. If either reading is 2cm or more from the manometer reading, turn unit off and calibrate the unit.

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Disassembly, Inspection, and Reassembly

Section 7.0

Disassembly, Inspection, and Reassembly
Inspect Case
Inspect Foot Pads
Inspect Keys and Switch Membrane
Inspect Rubber Gasket
Remove Case Cover
Remove and Inspect Circuit Board
Inspect Tubing
Wiring Inspection
Battery Voltage Check
Clean Case Inside and Outside
Unit Reassembly

Disassembly, Inspection and Reassembly

▼ The following instructions describe how to disassemble, inspect and reassemble the Pressure Alarm unit.

Caution: Observe all anti-static precautions before handling printed circuit boards! All persons handling static sensitive parts must be grounded via a 1MΩ resistive grounded wrist strap.

Inspect Case

▼ The Pressure Alarm case is made up of three parts: bottom half, top half, and battery compartment. Inspect each part for cracks, dents and other cosmetic damage. Replace all damaged case parts.

Inspect Foot Pads

▼ Inspect the two Dual Lock Fastener foot pads and the two rubber foot pads located on the rear panel of the pressure alarm. Tighten if foot pads are loose. Replace if damaged or worn. Dual Lock Fastener foot pads are to be positioned above the rubber foot pads. This allows the unit to hang correctly if attached to a vertical surface.

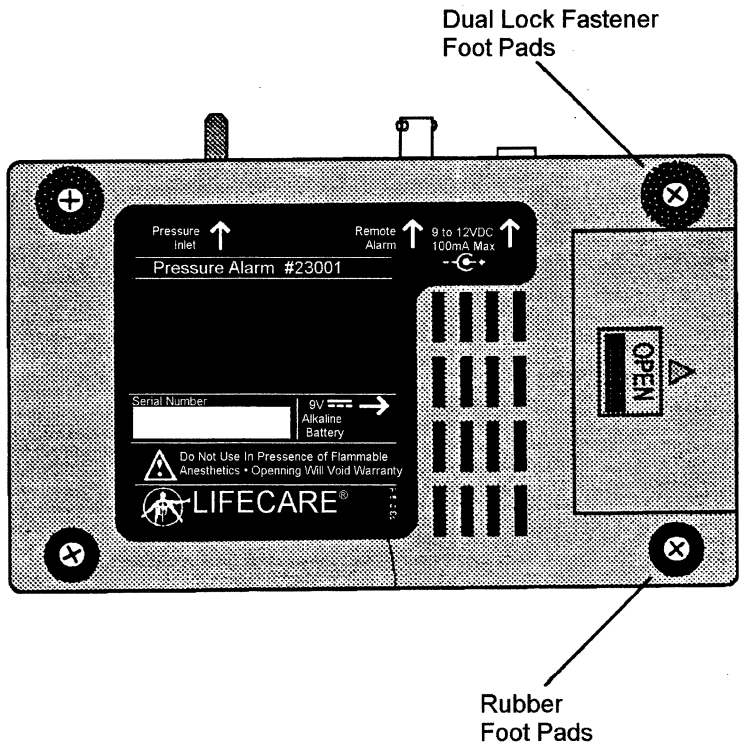


Figure 2 Foot Pad Inspection

Disassembly, Inspection, and Reassembly

Inspect Keys and Switch Membrane

▼ The switch membrane is external and mounted on the front panel. Inspect for tears, dents, and other cosmetic damage. Press each key on unit and assure that each "pops" back into place immediately after pressing. Replace switch membrane if a key is not working correctly or switch membrane is damaged. To remove, place top cover in freezer for two hours to make the glue brittle. Peel off damaged switch membrane and fit with new part.

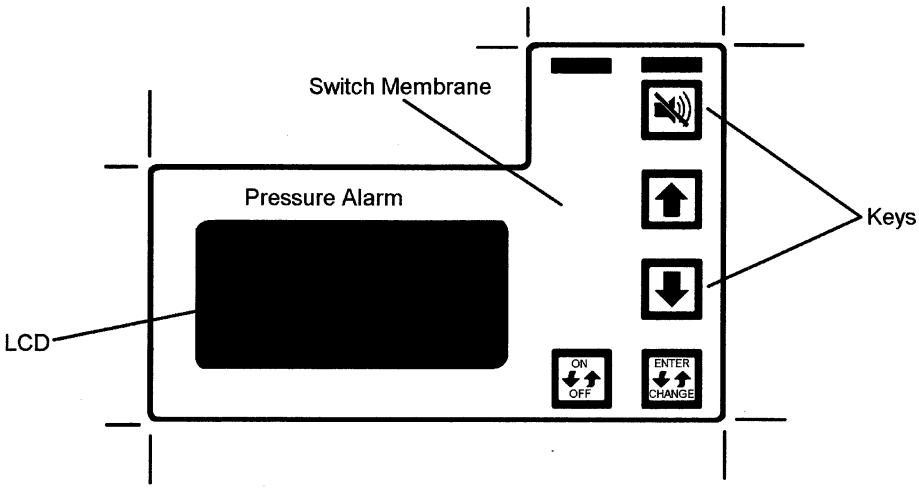


Figure 3 Switch Membrane

Inspect Rubber Gasket

▼ The Rubber gasket forms a complete seal between the two halves of the unit case. Inspect the gasket for tears, damage, or improper seating. If damaged, replace with a new gasket. Place a small drop of Loctite 414 on the bottom side of the indentation on the new gasket. Align the gasket on the bottom of case, with the indentation by the battery compartment.

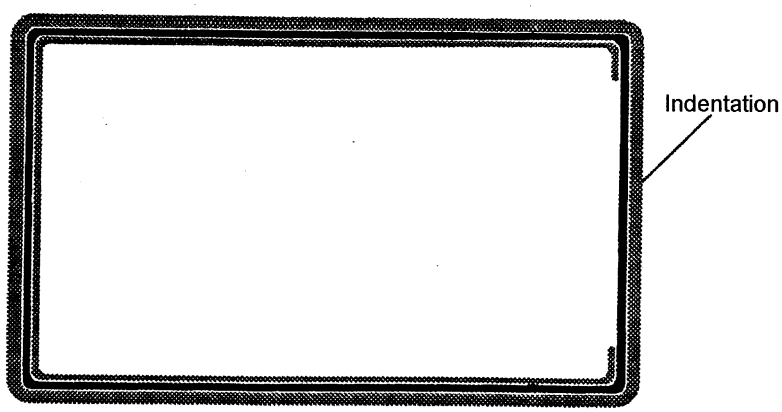


Figure 4 Gasket Placement

Remove Case Cover

▼ Ensure the unit is disconnected from the power pack and that the battery is removed. Remove the four screws visible on the bottom half of the case. Open the case slightly to expose silicone rubber tubing and connector.

To release cover, remove end of silicone rubber tubing from port hole on the pressure sensor. Unplug connector from its placement on board.

Remove the upper case half to gain access to the internal components. The rubber gasket is glued to the bottom half of the case by the battery compartment. The rubber gasket needs to remain seated on the bottom case half when removing the top half of the case. Removal of case top may cause the gasket to tear. If the gasket tears, repair or replace as necessary.

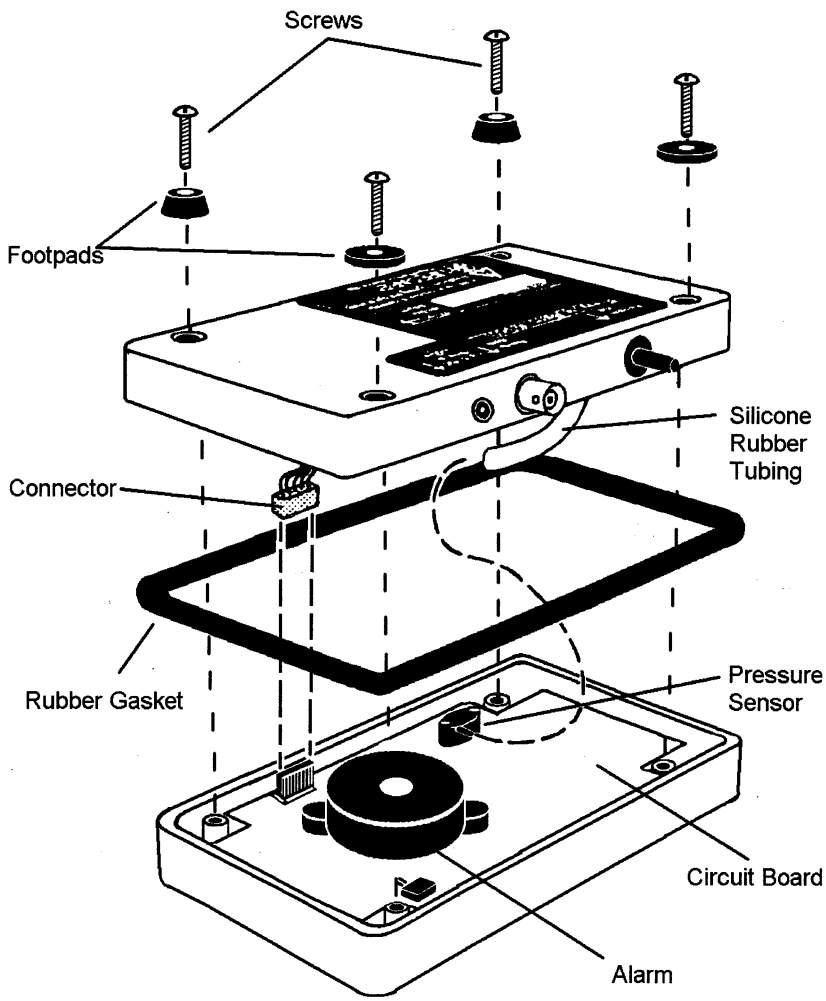


Figure 5 Unit Disassembly

Disassembly, Inspection, and Reassembly

Remove and Inspect Circuit Board

▼ Remove the three screws on the circuit board. Lift circuit board to expose Molex connector underneath. Detach Molex connector from the circuit board to release board from unit cover.

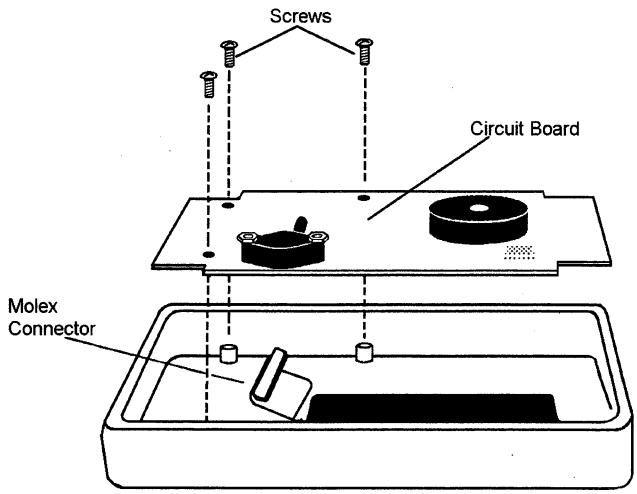


Figure 6 Circuit Board Removal

Erroneous signals can be the result of broken connectors. Inspect connectors on circuit board for visible damage. Inspect board components and LED casings for damage. Make sure LEDs are lined up correctly. Replace LEDs if cracked, loose, or damaged.

Inspect LCD for cracks, scratches, or damage. To remove LCD from circuit board, pull gently on both sides with even pressure.

Replace the microprocessor if it fails to work. Position a chip removing tool under two corners of the chip and pop chip out of placement. Seat the microprocessor chip with the "DOT" in line with the groove on the socket.

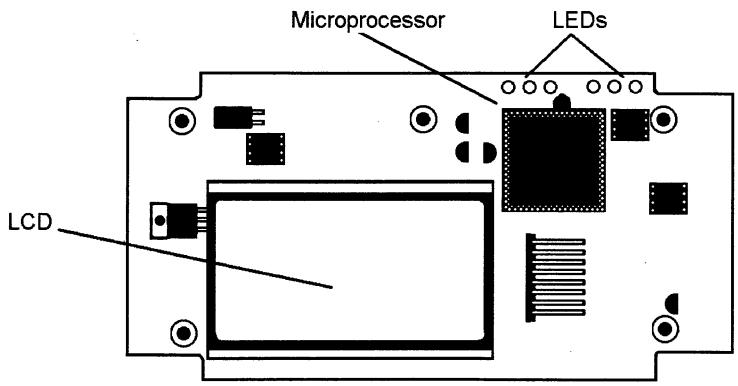


Figure 7 Circuit Board

Inspect Tubing

▼ Inspect the silicone rubber tubing for tears, punctures, and proper sealing. Replace tubing that appears soiled or shows signs of abrasion.

The pressure will be displayed incorrectly on the unit if the silicone rubber tubing has a loose fitting or pulls away from pressure inlet.

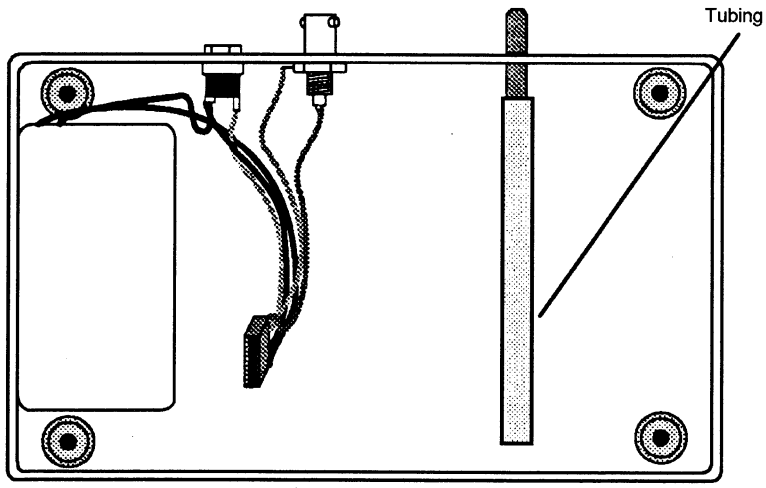


Figure 8 Tubing Inspection

Wiring Inspection

▼ Inspect all wiring for wear, crimping and secure connections. Replace any wire showing signs of abrasion or wear.

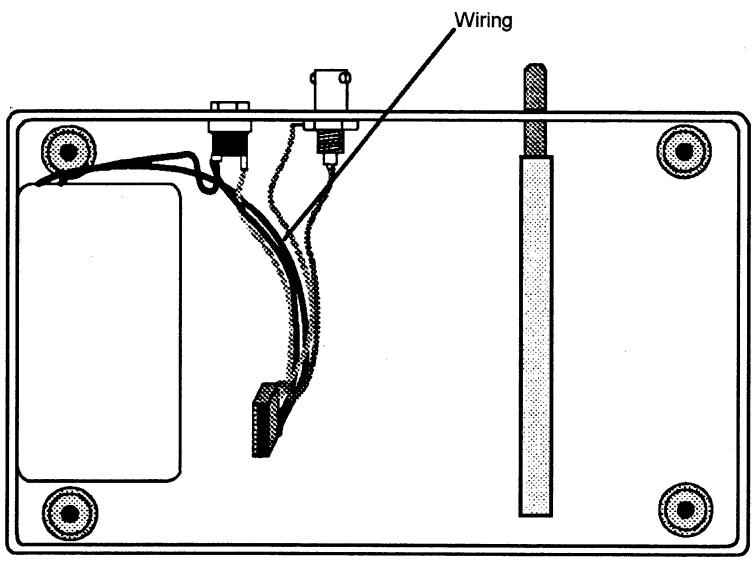


Figure 9 Wiring Inspection

Disassembly, Inspection, and Reassembly

Battery Voltage Check

▼ Remove battery and check with voltmeter. A battery is considered good if it has a minimum voltage of 8.5 VDC. Replace any battery that does not meet this specification

Clean Case Inside and Outside

▼ Clean outside of case during servicing. Wipe the unit clean with a damp cloth and disinfected with isopropyl alcohol (70%). Do not allow fluids or cleaning solutions to enter the alarm openings.

Clean the Pressure Alarm switch membrane using any of the common hospital disinfectants, e.g.: Acid Gluteraldehyde, Quaternary Ammonium compounds, Phenol based compounds, etc.

If sterilization is desired, sterilize the Pressure Alarm using LOW TEMPERATURE ETHYLENE OXIDE ONLY (i.e. less than 120° Fahrenheit and 60% Relative Humidity). In addition, make sure to REMOVE THE BATTERY BEFORE STERILIZATION.

DO NOT steam autoclave the Pressure Alarm unit.

Unit Reassembly

▼ Replace LCD by positioning legs into sockets. Push down gently into place.

Reattach Molex connector to circuit board. Gently position circuit board into place inside case. Replace the three circuit boards screws.

Ensure rubber gasket is positioned correctly with indentation glued to the bottom half of case cover. Place silicone rubber tubing securely over port hole. Replace cover, taking care not to fold or pinch the gasket.

Before replacing the bottom case half, check that there are no loose items in the case. Check that wiring and tubing cannot become trapped as the bottom case half is fitted. Position and replace foot pads with velcro pads above rubber foot pads to allow unit to hang correctly if attached to a vertical surface. Tighten the four screws hand tight.

Unit Reassembly
Continued

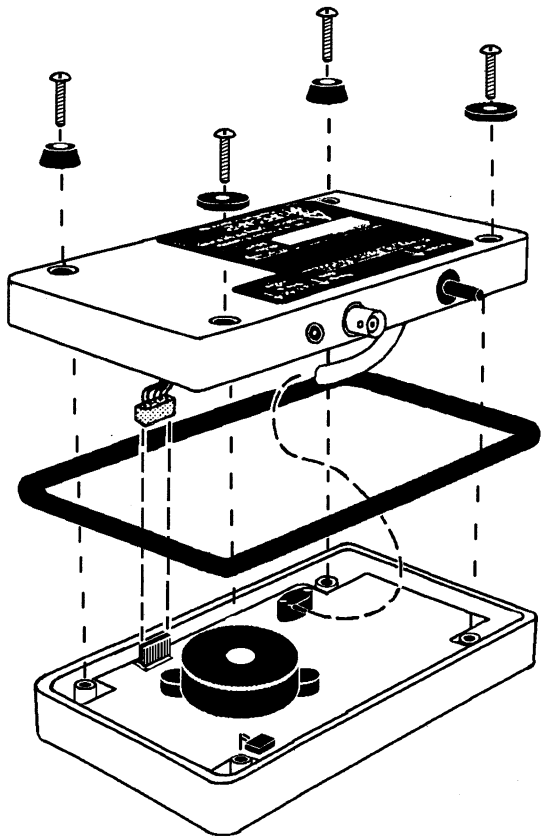


Figure 10 Unit Reassembly

NOTE: After disassembling the Pressure Alarm for inspection or repair, the unit should be checked for accurate pressure readings. If inaccurate, calibrate the unit. Refer to Section 11.0 for instructions on unit testing and calibration.

Operational Modes

Section 8.0

Operational Modes
Pressure Alarm Settings
CPAP Alarm Settings
Negative Inspiratory Force Measurements
Alarm Adjustments
Turning Off the Pressure Alarm

Operational Modes

▼ The Pressure Alarm has three operational modes. The user may change from one mode to another by pressing the UP or Down arrow, once it has passed the diagnostic check and goes into operation.

Set Point Mode - This mode is displayed after the diagnostic check when the unit is turned On or the unit is returned to the operation mode. The Alarm Set Point and the Alarm Delay Time is displayed on the screen. The unit continues to monitor the pressure reading and the alarm will be activated if an alarm condition exists.

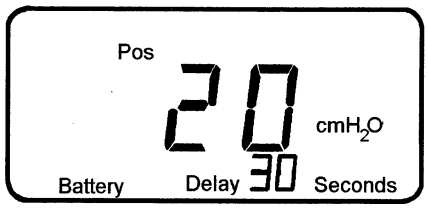


Figure 11 Set Point Mode LCD Display

Peak Pressure Mode - This mode displays the highest positive pressure and lowest negative pressure detected during a respiratory cycle and holds that value on the screen until the next peak pressure point (positive or negative) is detected. "PP" (peak pressure) is displayed in the LCD window.

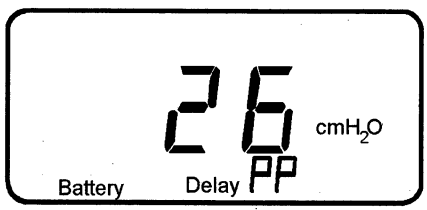


Figure 12 Peak Pressure Mode LCD Display

Continuous Pressure Mode - This mode displays the actual pressure detected at the pressure sensor. "CP" (continuous pressure) is displayed in the LCD window.

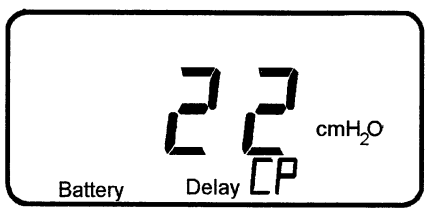


Figure 13 Continuous Pressure Mode LCD Display

Pressure Alarm Settings

Caution: When setting alarm values, if no value has been entered within 30 seconds the unit returns to the operational mode. While setting alarm values the Pressure Alarm cannot detect an alarm condition.

NOTE: Once the Pressure Alarm has been turned ON, all the alarm setting changes, including switch OFF must be made in conjunction with the Enter/Change key. This feature is designed to prevent inadvertent setting changes. The Pressure Alarm can be set to display cmH_2O or kPa.

1. To change an alarm setting, press the Enter/Change key until "Set/Off" and the desired value flashes.

2. The first value to flash is the Set/Off and the word "Neg" (or the word "Pos"). To change this value, press the arrow keys until the desired value is displayed. This value determines whether the alarm set point is a positive or negative value. To enter it and move on to another value, press the Enter/Change key.

3. The second value to flash is the first digit of the Pressure Alarm set point and the word "cmH_2O", (or "kPa"). To increase or decrease this value, press the Up or Down arrow key. To enter this value and move on to the next digit, press the Enter/Change key. Once both digits are set, press the Enter/Change key.

4. The third value to flash is the first digit of the alarm delay time and the word "seconds". To increase or decrease this value, use the Up or Down Arrow key. To enter this value and move on the next digit, press the Enter/Change key. Once both digits are set, press the Enter/Change key. The display will read "run" and the operation begins.

5. To change any value, press the Enter/Change key again and it starts over at Step 2.

6. The Pressure Alarm may be turned OFF any time the Enter/Change key has been pressed and the words "Set/Off" are flashing by pressing the On/Off key.

CPAP Alarm Settings

▼ CPAP Alarm settings

1. Turn the Pressure Alarm ON.

2. Press an Arrow key to enter the Continuous Pressure Mode ("CP" is displayed in the delay window).

3. Observe the CPAP pressure being delivered to the patient.

4. Use the procedure for alarm settings and set the Positive Alarm set-point at the same level as the CPAP being delivered.

CPAP Alarm Settings
Continued

NOTE: The alarm now sounds if the CPAP increases above or falls below the desired CPAP level for longer than the time delay setting. The Pressure Alarm must detect a pressure change of 1.0 cmH_2O to reset the Alarm Delay. The use of Continuous Pressure Operational Mode may be desired when monitoring CPAP.

Negative Inspiratory Force Measurement

▼ Negative Inspiratory Force Measurement settings.

1. Turn the Pressure Alarm ON and observe diagnostic check.
2. Use the Alarm Setting Procedure and set the Alarm Set-Point and Alarm Delay at high enough levels that an inadvertent alarm is not activated during the procedure.
3. Select Peak Pressure Mode. "PP" is displayed in the Alarm Delay Window.
4. Connect the 3/16" ID tubing to the Pressure Alarm and the other end of the tubing to the Negative Force Adapter.
5. Create a closed system by occluding the inspiratory valve with your hand.
6. The Peak Negative Pressure is displayed on the Pressure Alarm.

Alarm Adjustments

▼ To make adjustments to the alarm settings simply press the Enter/Change key until the desired value is flashing and use the arrow keys to set the desired level. Then press the Enter/Change key until the words "Set/Off" no longer flash.

Turning Off the Pressure Alarm

▼ To turn the Pressure Alarm OFF, press the Enter/Change key until "Set/Off" is flashing and press the ON/OFF Key.

Alarm Conditions

Section 9.0

Alarm Conditions
Low Pressure Alarm
Persistent High Pressure Alarm
CPAP Alarm
Switched to Internal Battery Alarm
Replace Internal Battery Alarm
Microprocessor
Hospital Alarm Interface
Remote Alarm Interface
Remote Alarm Circuit

Alarm Conditions

▼ The Pressure Alarm monitors the pressure alarm set-point and resets the delay period every time the pressure passes that set-point. This is indicated by the word "Delay" flashing every time it is reset. If the delay period is not reset, the Pressure Alarm goes into an alarm condition at the end of the delay period. The word "Delay" does not flash during the Alarm Setting Procedure.

Low Pressure Alarm

▼ Whenever the Peak Pressure DOES NOT EQUAL OR EXCEED the Pressure Alarm Set-Point within the delay time period set, the Pressure Alarm sounds the audible alarm (pulsed in groups of three), the words "Low" and "Pressure" flash, and the RED ALARM LED ILLUMINATES. The audible alarm continues to sound until the condition is corrected or the 30 Second Alarm Silence key is pressed.

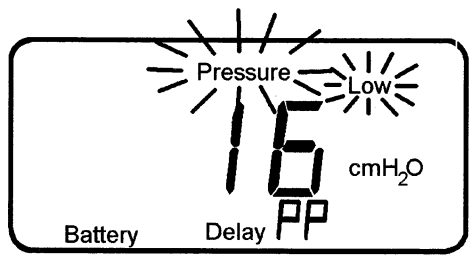


Figure 14 Low Pressure Alarm LCD Display

Persistent High Pressure Alarm

▼ If the Peak Pressure EXCEEDS AND STAYS ABOVE the Pressure Alarm Set-Point after the delay time period set (i.e. inflation hold, occluded expiratory limb, low pressure alarm set point below PEEP level, etc.), the audible alarm sounds (pulsed in groups of three), the words "High" and "Pressure" flash, and the RED ALARM LED ILLUMINATES. The audible alarm continues to sound until the condition is corrected OR the 30 Second Alarm Silence key is pressed

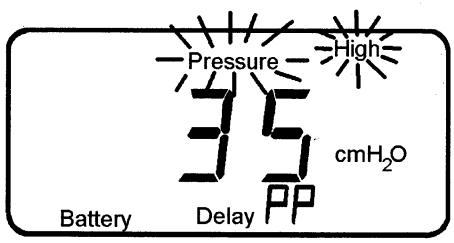


Figure 15 Persistent High Pressure Alarm LCD Display

Alarm Conditions

CPAP Alarm

▼ If the CPAP pressure wave form remains ABOVE OR BELOW the Pressure Alarm Set-Point for longer than the delay time period set, the Pressure Alarm sounds the audible alarm (pulsed in groups of three), the words "Pressure" and "High" or "Low" flash, and the RED ALARM LED ILLUMINATES. The audible alarm continues to sound until the condition is corrected OR the 30 Second Alarm Silence key is pressed.

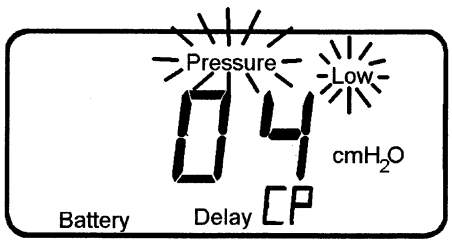


Figure 16 CPAP Alarm LCD Display

Switched to Internal Battery Alarm

▼ Whenever the power source changes from AC (9 volt DC Converter) to DC (Internal Battery), the Pressure Alarm will:

1. Sound the audible alarm pulsed in groups of three until interrupted by the operator.
2. Flash the word "Battery" on the LCD.
3. Red alarm LEDs illuminate.

To cancel the audible alarm, press the 30 Second Alarm Silence key. The word "Battery" is now displayed constantly and the red LEDs turn off.

If the AC power source returns before cancellation, the Pressure Alarm will:

1. Silence the audible alarm.
2. The word "Battery" disappears.
3. Turn off the red LEDs.

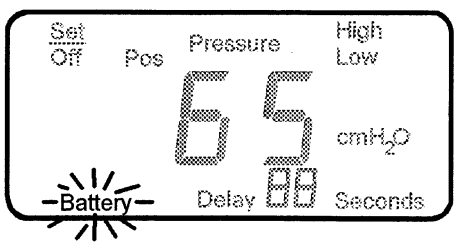


Figure 17 Switch to Internal Battery Alarm LCD Display

Replace Internal Battery Alarm

▼ When the internal Battery voltage reaches 7 volts, the Pressure Alarm will:

1. Flashes the words "Replace Battery" on the LCD.
2. Sounds the audible alarm pulsed in groups of three every 15 seconds.
3. Illuminates red alarm LEDs.

When the Internal Battery voltage reaches 6.5 volts, the Pressure Alarm will:

1. Flashes the words "Replace Battery" on the LCD.
2. Sounds the audible alarm pulsed in groups of three until the unit fails.
3. Illuminates red alarm LEDs.

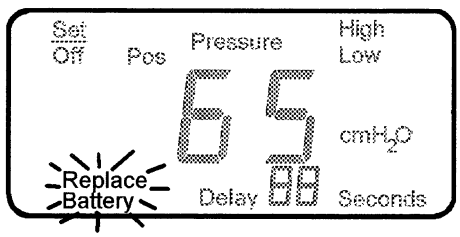


Figure 18 Replace Battery LCD Display

Microprocessor

▼ The pressure Alarm is equipped with a sophisticated internal microprocessor monitoring system. If the microprocessor fails, the Pressure Alarm sounds the audible alarm CONTINUOUSLY, illuminates the red alarm LED and displays the word "Err" on the LCD.

Caution: If the microprocessor fails, DO NOT USE THIS EQUIPMENT UNTIL IT HAS BEEN SERVICED BY AUTHORIZED PERSONNEL.

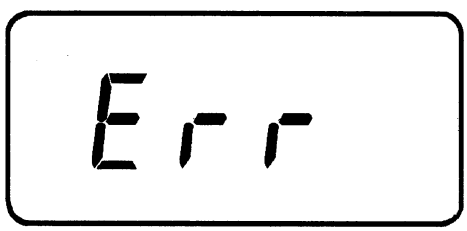


Figure 19 Microprocessor Failure LCD Display

Alarm Conditions

Hospital Alarm Interface

▼ The Pressure Alarm has the capability of connecting to most hospital call and alarm systems. Verify whether the institution's system is a Normally Open or Normally Closed circuit. A Normally Open circuit system refers to an alarm system that must see an open circuit in normal (no alarm) condition and a closed circuit in alarm conditions. A normally closed circuit system must see a closed circuit in normal (no alarm) conditions and an open circuit in alarm conditions. Use the following procedure to adapt the Pressure Alarm to Normally Closed or Normally Open.

NOTE: The slide switch located in the battery compartment must be positioned in the Hospital Alarm position to interface with a hospital call or alarm system.

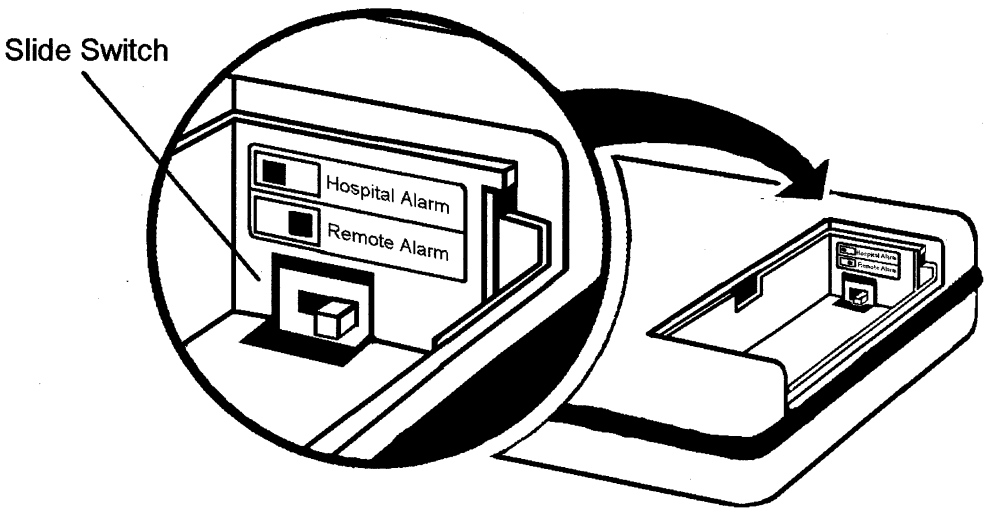


Figure 20 Hospital Alarm/Remote Alarm Settings

1. If the alarm switch is in Remote Alarm position, NO and NC (Normally Open and Normally Closed) are not options in the calibration procedure. The default mode is NO. This does not change and interfaces only with the LIFECARE Remote Alarm.

2. After putting the alarm switch in Hospital Alarm,

   a. Press the Enter/Change key so that "Set/Off" is flashing.

   b. Press the Alarm Silence key and the UP Arrow key simultaneously. The current setting, either NO or NC is displayed. Use either Arrow key to change to the other setting.

   c. Press the Enter/Change key to save the new setting and return to normal operation.

Remote Alarm Interface

▼ The Remote Alarm alerts the user of an alarm condition at a distance of up to 300 feet from the Pressure Alarm. It comes with a non-detachable 50 foot signal cord. An audible tone sounds and a red light flashes to indicate that an alarm condition exists.

Power is supplied by an internal 9 VDC alkaline battery that provides at least two weeks of continuous operation. The unit can also operate on household current by use of the DC converter. The Remote Alarm sounds if the cable connecting it to the Pressure Alarm becomes disconnected or shorted.

A "Self-Test" circuit constantly checks the internal circuitry, and if an internal failure is detected, the alarm sounds to alert the user that the Remote Alarm is not functioning properly. The Remote Alarm can also function with a Call Button. Refer to the Remote Alarm User's manual for details of operation and accessory list.

Remote Alarm Circuit

▼ The external remote alarm is controlled by the microcontroller which drives a solid-state relay circuit made up of Q2 (power FET) and diodes D4 through D7. Unlike a mechanical relay, the circuit draws no power from the Pressure Alarm. The diodes make up a bridge circuit that allows control of currents up to one ampere AC or DC with either polarity of up to 50 volts. Except for a voltage drop of about one volt (at low currents, or one and one half volts at high currents), the circuit appears to external circuitry the same as mechanical relay contacts. The circuit can appear as a normally open or normally closed contact under software control.

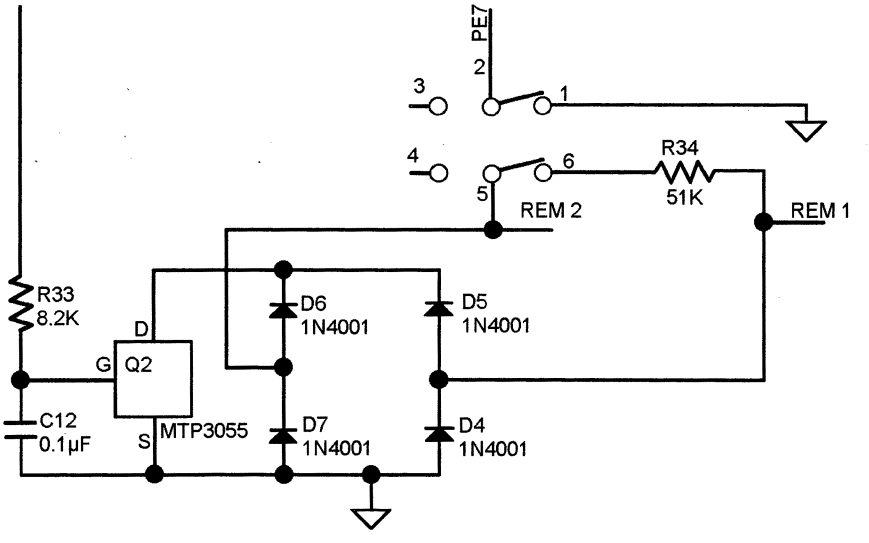


Figure 21 Remote Alarm Circuit

Theory of Operation

Section 10.0

Theory of Operation
Power Input and Voltage Regulator
Microprocessor
Clock Generator-Oscillator
Pressure Transducer and Amplifier
Alarms and Indicators
Liquid Crystal Display and Driver

Theory of Operation

▼ All Pressure Alarm electronic components are located on the printed circuit board assembly. The PCB assembly mounts inside the case assembly and plug-connects to a simple wire harness. This completes connection to the battery, the power adapter input connector, and the output connector for interfacing with an external alarm device. The electronics on the PCB and the software that drives the unit have been designed for minimal part count and very low power consumption. The pressure transducer, for instance, is a relatively low impedance device that requires too much current for continual operation. The software and associated hardware, allow the pressure transducer to be turned on only long enough for the analog to digital converter to get a reading.

The drives current duty cycle is only 5%. The microprocessor, in normal run modes, shuts itself down after taking each reading (every 131 ms) to further save power. Under normal operating conditions, the Pressure Alarm only draws 1.5 mA from the battery or external power supply. In Change Settings mode the unit draws about 2 mA, and when alarm in Normal Run modes, the unit draws about 2 mA. Battery life is approximately 2 weeks.

The Pressure Alarm has three normal run modes: Display Settings, Actual Continuous Pressure, and Peak Pressure. These differ only in display format. Actual pressure is measured every 131 ms (one eighth second). All alarm condition checks and other calculations are done at this rate. Each eighth second, the microprocessor takes a reading from the pressure transducer with an accuracy of better than 1%. When other factors are considered, such as the linearity specifications of the transducer, system accuracy will be within 3%. Due to the digital nature of the system, there can be an additional error of plus or minus 1 count. System accuracy can be stated as plus or minus 3%, plus or minus 1 count after recalibration of zero pressure.

Power input to the Pressure Alarm comes in on connector J1 on the PCB by way of a five-wire harness with plug P1. The harness is permanently pre-wired to several components that are mounted to the bottom cover of the case. They are: BC1, the battery connector which gets plugged into B1, a nine-volt battery (alkaline recommended); PJ1, the external power jack; and BNC1, the external alarm connector. Plug P1 on the harness is non-locking for ease of removal from the mating connector J1 on the PCB. When the case is assembled, P1 is secured to J1.

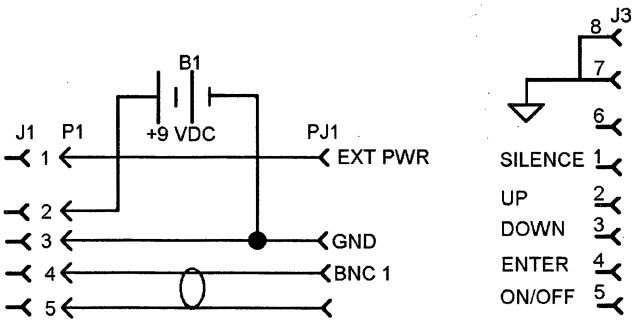


Figure 22 Power Input

Theory of Operation

Theory of Operation
Continued

The membrane switch assembly plugs into a connector on the component side of the PCB. All remaining electronics are mounted on the PCB. The transducer mechanically connects to the nipple on the back of the bottom case cover with a short section of 1/8 ID silicone rubber tubing.

The Pressure Alarm PCB assembly can be broken down into six major functional blocks: Power Input and Voltage Regulator, Microprocessor, Clock Generator - Oscillator, Pressure Transducer and Amplifier, Alarms and Indicators, and Liquid Crystal Display and Driver. The functional block and function(s) of each component on the PCB are defined below.

Power Input and Voltage Regulator

▼ Pin 1 of J1 is the external power input source to the PCB. Pin 2 is the battery power input source. Pin 3 is the power ground return. C1 is a high frequency bypass capacitor for removal of any noise coming in from the external power adapter. It also serves to block internally generated interference out of the Pressure Alarm to avoid radiation from the external adapter cord. Radiation from the external alarm cord is avoided by the cord shield. D1 and D2 protect the PCB circuitry from damage caused by reversed polarity from either the external adapter or the battery. D1 and D2 also form an automatic voltage switch isolating the battery from the external supply and electrically remove the battery from the circuit when external power is being used. R1 further aids in isolation between the battery and the external supply. R1, C2 and C3 make up a filter circuit that remove transients that come in from the external power source. Transients are caused by power line variations and natural spikes produced by plugging in and removing external power. Voltage variations are absorbed across R1. Low frequency voltage variations are smoothed by C2 and high frequency noise by C3. The voltage (+9V) which goes into the five-volt regulator side (+5V) which could affect the microprocessor's reset line or analog to digital converter readings.

U1 is a five-volt precision regulator that furnishes operating power to the logic circuits on the PCB. It also provides power for the pressure transducer, as well as the reference voltage for A to D readings of the transducer's output. U1 has a shut down input on pin-5. This is used to keep the Pressure Alarm turned OFF except when the input is being pulled down by the microprocessor while in the ON state.

Power to the Pressure Alarm is accomplished as follows: When the system is in the OFF state, the shut down pin of U1 is pulled up by R2 to plus nine volts. This keeps the regulator disabled. When disabled, U1's power consumption is only a few microamps. This minimal amount of power combined with all other power consumption and leakage during OFF mode, minimizes the draw on the battery. For this reason, the battery should only be removed during long periods of storage or non-use. When the ON/OFF key (at J3 pin-5) is pressed, the cathode of D3 is grounded, pulling down pin-5 of U1. U1 turns on and furnishes power to all the logic circuits, including the microprocessor and U2. The software starts running and the processor activates the control line at U2 pin-4 by pulling it down. This allows U2 pin-3 to pull down U1 pin-5, locking the system in the ON state. The system then goes into normal run mode.

Power Input and Voltage Regulator
Continued

▼ In order to turn the system OFF, the processor disables the signal at U2 pin-4 when the ON/OFF key is pressed from within Change Settings mode. Software shuts down the system once the user's finger is removed from the key. The processor turns on the transducer and quickly draws down the power output (+5V) from U1. As the voltage falls below 4.5 volts, U3 (Low Voltage Sensor) will pull down the processor Reset line. This disables any other processor activity. U3 protects the EEPROM variables in the processor by pulling the Reset line whenever operating voltage is not sufficient.

C4 bypasses any noise from the shut down input of U1. J2-3 is pin-3 on connector J2, which is a 16-pin connector of test points. Connecting a jumper between J2-3 and GND (J2-10) will override processor control and hold the Pressure Alarm in the ON state for testing and calibration purpose. J2-7 is the plus-five-volt test point. R7 pulls up the Reset line to the microprocessor when the line is not being pulled down by U3, or J2-5. This is the test point for monitoring the Reset line or for activating Reset by jumping the ground during testing.

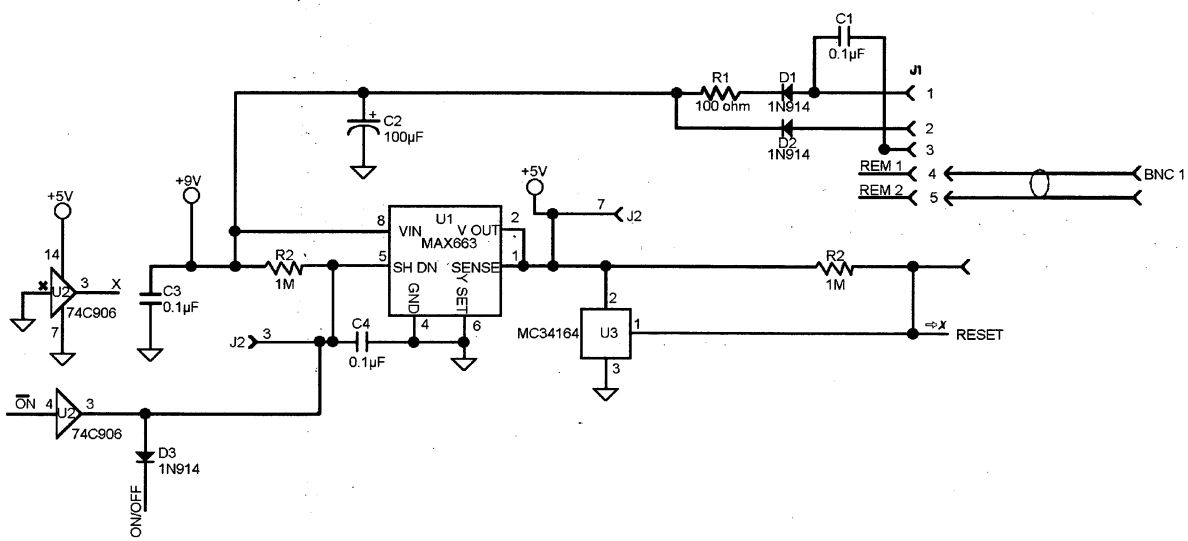


Figure 23 Power Input and Voltage Regulator

Microprocessor

▼ U4 is the microprocessor which controls the Pressure Alarm system. It is a self-contained controller (Mortorola, MC68HC811E2) that requires no additional support circuits or memory. It has input lines for monitoring key closures, analog inputs to the analog to digital converter, and control inputs. It has output lines that control other logic on the PCB, the audible alarm, external alarm, and indicator LEDs. The processor operates in Single Chip mode and executes software from two kilobytes of internal electrically erasable read only memory (EEPROM). This has been programmed with software, and with variables modified during calibration, and during operation as settings are changed. C5 is the bypass capacitor for the processor. It serves as a bulk filter for the regulated logic voltage (+5V).

R8 and R9 form a voltage divider that allows the microprocessor to monitor battery voltage or external input voltage. The divided down voltage enters the processor at the first analog input PE0. The divider is of high impedance to draw negligible power. When the external power adapter is connected, the processor will read a voltage in excess of 9.75 volts (minus the 0.6 volt drop across D1). This indicates that external power is being used, since the battery voltage will always be lower than 9.75 volts. D2 will be reversed biased at this time, and the battery will not produce current. Current Does not flow through R1 at this time. The processor reads the battery voltage when the external adapter is not connected. This reading allows for the 0.6 volt drop across D2.

The keypad (membrane switch assembly) plugs into J3 on the PCB. This keypad is the user interface to the Pressure Alarm. The keypad has five key-closure (active low) input lines which directly connect to the microprocessor, and two ground connections. Each input is pulled up to plus five volts with a resistor, R24 through R28. Lines are activated (pulled down) when keys are pressed. Pin-4 of the processor is an input pin that must be tied to a valid logic level. It is tied to one of the key inputs (up arrow in this case). Three auxiliary inputs and one output from the processor are tied to test points J2-9, J2-11, J2-13. J2-8, R11, R12 and R13 are pull-down resistors for the three inputs.

Theory of Operation

Clock Generator-Oscillator

▼ U5 is the clock generator for the processor. It is a timer circuit used in a free running oscillator mode using R10 and the input capacitance of pines 2 and 6 to set the frequency. An Intersil part is used since it has lower input capacitance and uses less power. The frequency is set to 500 KHz during initial factory calibration by selecting and installing a 5% resistor. Test point J2-6 (and GND) may be connected to an oscilloscope or frequency counter to observe the frequency. C6 is the bypass capacitor for U5. It serves as a second bypass for the processor U4.

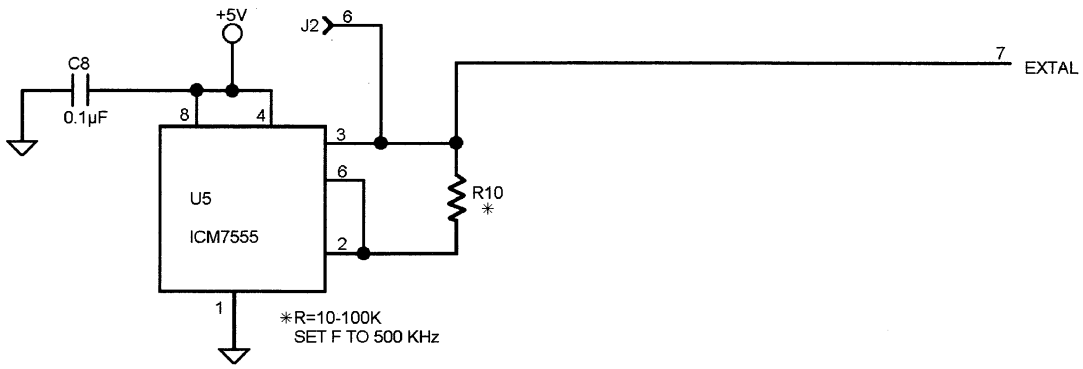


Figure 25 Clock Generator/Oscillator

Pressure Transducer and Amplifier

▼ PT1 is a pressure transducer utilizing a monolithic piezoresistor strain gage which generates a changing output voltage with variations in applied pressure. The device used is a Motorola, MPX10GP rate for positive pressures up to 1.5 PSI or over 100 cm of water. The device can withstand positive or negative overpressures up to ten times its operating range without damage. In its normal operating range, the device has excellent linearity, even when used as a negative pressure sensor. The transducer in the Pressure Alarm is used for both negative and positive pressures in the range -99 to +99 cm water, or -9.9 to +9.9 kPa.

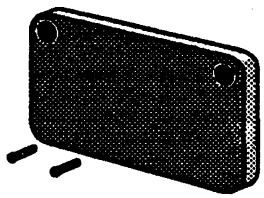
PT1 has an internal resistance of 500 ohms between the driving pins-3 and 1. A positive driving voltage is applied to pin-3. Pin-1 is grounded. The Q1 switch allows the processor to apply driving voltage to the transducer long enough to take a reading. R23 limits the current to 3.3 mA, twice the current used by the entire Pressure Alarm system. The processor limits the average current drawn by the transducer to 170 microamps by driving the transducer only 7 ms out of every 131 ms (long enough to get a new reading). The driving voltage to R23 is five volts. One third of this voltage is applied across PT1. The output voltages from PT1 on pin-2 and pin-4 are each close to half the driving voltage, with pin-2 slightly more positive than pin-4 when zero pressure is applied. The voltage difference between pin-2 and pin-4 is the output voltage from the transducer which varies linearly with applied pressure. This voltage difference is 12 millivolts with zero pressure applied. This in known as the Offset Voltage.

When positive pressure is applied to the transducer, the voltage becomes more positive. With 100 cm water pressure applied, the voltage increases linearly by about 18 mV. This is the Full Scale Span Voltage. When minus 100 cm of water pressure is applied, the voltage drops linearly by the same amount. The voltage between pin-2 and pin-4 of a typical transducer varies from 12 mV at zero pressure to -6 mV at -100 cm pressure, to +30 mV at +100 cm pressure.

Accessories

Mounting Accessories
Continued

27920 Ventilator Mounting Kit
This mounting method secures the Pressure Alarm to the side panel of the PLV series ventilators. This mount is also a component of the Pole Mount and Iron Lung Mounts. The mount is easily mounted onto a ventilator system with screws.



27920

27919 Pole Mount Adapter Kit
The users may purchase this kit if they already have the ventilator mount (p/n 27920). This kit contains the "C" clamp, knob and necessary hardware.

23904 Iron Lung Adapter Kit
This kit, when assembled with the ventilator mounting plate (p/n 27920), allow the pressure alarm to be mounted on the Iron Lung or Portalung. This entire assembly including the mounting plate, can be ordered as p/n 23902, Iron Lung Mounting Kit.

23907 Universal Dual Lock Fastener
This 1" X 6" strip has double-back tape secured to the back and mounts the Pressure Alarm to a variety of surfaces. This method of mounting can be used with the 170C and portable ventilators. Cut the tape to size and attach to system with adhesive. The two top foot pads on the pressure alarm are made of dual lock tape and will hold securely when attached to tape on ventilator system.

34046 Stand
This is the same stand used for the remote alarm. The alarm stand is placed in an upright position to hold the pressure alarm unit in place for easy display.

Additional Accessories

23061 Carrying Case
This case is grey with the LIFECARE logo on the outside.

06441 Hydrophobic Filter, Disposable
This filter acts as an in-line water trap. It offers extremely low resistance, even when wet.

34001 LIFECARE Remote Alarm

Pressure Transducer and Amplifier
Continued

The voltage output from PT1 is amplified by U6 (dual operational amplifier). The first section of U6 is used to amplify the transducer's output by a factor of about 122. This creates voltages or use by the analog to digital converter in the microprocessor. R22 (8.2k) and R16 (1M) set the gain to 122. R21 and R15 form a similar network at the positive input. R22 has the same value as R21 (8.2k). Due to variations in output voltages from different sensors, the gain must be adjustable to allow for the variations. During the manufacturing pre-calibration process, R22 is selected to give an appropriate full-scale voltage swing from U6 pin-1 of about 4.4 volts as the pressure varies from -100 cm to +100 cm.

At zero pressure, the output from U6 pin-1 is pre-calibrated to 2.5 volts. This is accomplished by using the second amplifier section of U6 to feed back a positive offset (pseudo-ground reference) voltage to the first stage of U6. R19 and R18 form a voltage divider for tapping off a portion of the supply voltage (+5V) that enters the positive input of the second amplifier. R20 and R17 set the gain of this amplifier section to 0.5 and compensate for temperature voltage variations in the transducer as explained below. By selecting an appropriate value for R18, the voltage output at U6 pin-1 can be pre-calibrated to 2.5 volts with zero pressure applied. This compensates for amplifier offset voltages, transducer offset variations, and temperature variations. Selection of R18 and R22 are interactive. One affects the other. Test points J2-14, J2-16 and J2-12 (and GND) are of assistance when selecting the resistors. They allow external fixtures (resistors) to be temporarily connected. J2-4 is the test point for monitoring the voltage on U6 pin-1. J2-15 can be connected to plus five volts to turn on Q1. This enables drive current to the transducer during the selection of R18 and R22. R14 isolates J2-15 from the processor driving signal.

The pressure transducer is sensitive to changes in temperature and has been designed to automatically compensate for some of these variations. In conjunction with R23, temperature compensation for full scale span is automatic. When a resistor is placed in series with the transducer, it will affect how the temperature compensation responds. When the series resistor is twice the values of the internal resistance of the transducer, good span compensation results. The resistor must have a temperature coefficient that is slightly negative. As the automatic span compensation functions in the transducer, the drive voltage to the transducer varies.

Half of this change in drive voltage is felt at each of the transducer outputs, causing the effective DC offset voltage at the input of the amplifier to shift. To cancel this effect, the drive voltage to the transducer at pin-3 is fed back to the second section of U6 through R20 and R17 at the negative input of this section of U6. Because the gain of this section is one-half, half of the drive voltage variation is fed back to compensate for the error generated by automatic span compensation for temperature in PT1.

U6 and the associated circuitry are analog in nature and typically susceptible to noise and voltage variations on the traces of a PCB. For this reason, a single-point ground is used in this area. Pin-1 of PT1, the bottom side of R18, pin-4 of U6, and pin-51 of the microprocessor (A to D voltage reference, low) are all connected to a single point on the PCB at pin-4 of U6 (GND). The drive side of R23, pin-52 of the processor, the top of R19, and pin-8 of U6 all connect to a single point on the PCB at pin-8 of U6 (+5V). C7 is the bypass capacitor for U6.

Pressure Transducer and Amplifier
Continued

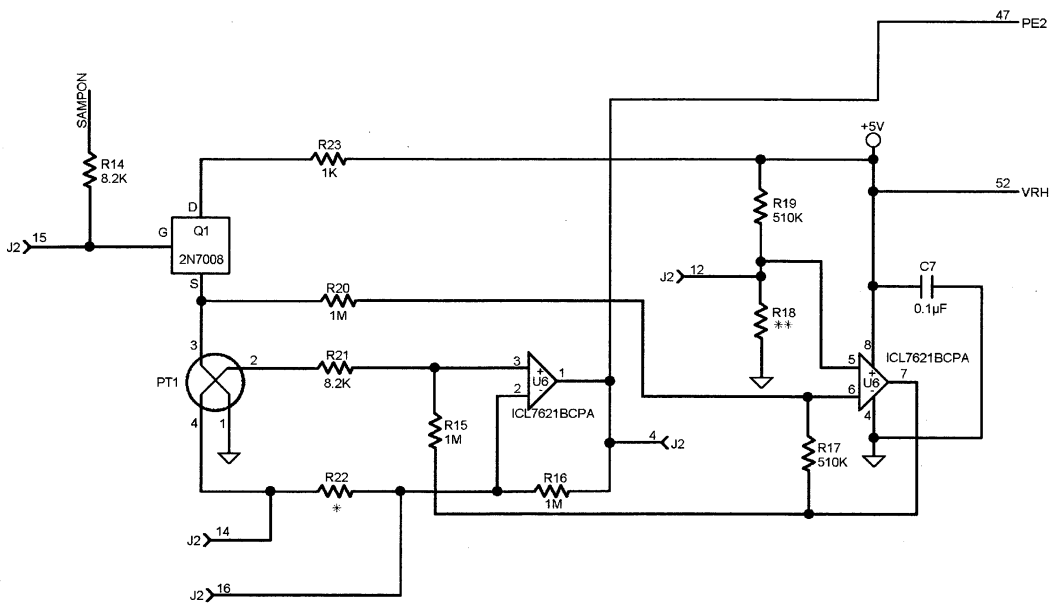


Figure 26 Pressure Transducer and Amplifier

Alarms and Indicators

▼ The audible alarm on the PCB is a self-contained device that is turned on by applying a DC voltage. The alarm is controlled by the processor by way of two sections of U2. U2 is a hex-open-drain type buffer. Two sections are connected to drive the alarm by pulling down its negative line to near ground. The positive side is connected to the unregulated input voltage (+9V). When the system is running on battery, the alarm will be driven with about 8.5 volts and will have a sound pressure level of more than 90 db. When the external power adaptor is used, the sound level is higher.

The yellow and red visual indicators are each made up of three LEDs in series. The unregulated voltage (+9V) is sufficient to illuminate three devices in series, allowing three times as much light to be generated with the same amount of current it would take to drive one. One section of U2 (pin-11) drives the red LEDs, L1, L2, and L3, with R5 as the current limiting resistor. Another section of U2 (pin-9) drives the yellow LEDs, L4, L5, and L6, with R6 as the current limiting resistor. The remaining section of U2 is a spare with its input pin-6 tied to ground. The LEDs are always driven in pulses in order to limit average power consumption.

Alarms and Indicators
Continued

The external alarm is controlled by pin-24 of the processor. This pin drives a solid-state relay circuit made up of Q2 (power FET) and diodes D4 through D7. Unlike a mechanical relay, the circuit draws no power from the Pressure Alarm. The diodes make up a bridge circuit that allows control of the currents up to one ampere AC or DC, with either polarity up to 50 volts. Except for a voltage drop of about one volt across the diodes, the circuit appears to external circuitry the same as mechanical relay contacts. The circuit can appear as normally-open or normally-closed contacts by setting the switch in the battery compartment to Hospital Alarm. R34 supplies the necessary loading for operation with a LIFECARE Remote Alarm device. C12 and R33 protect the gate of Q2 from transients. To make the Pressure Alarm compatible with the LIFECARE Remote Alarm, set the switch in the battery compartment to Remote Alarm.

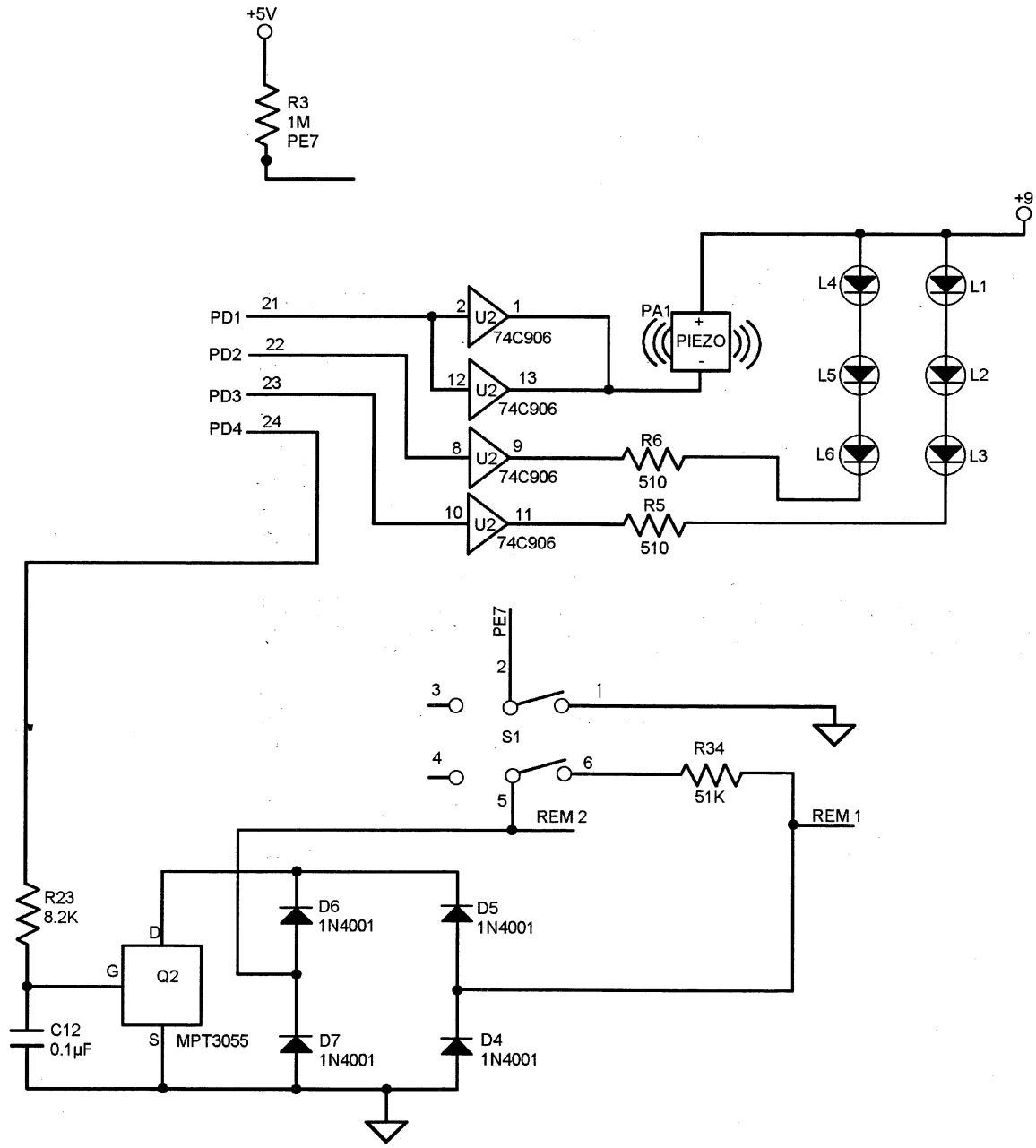


Figure 27 Alarms and Indicators

Theory of Operation

The external alarm is controlled by pin 24 of the microprocessor. This pin drives the solid state relay made up of Q2 (a power FET) and the diode bridge consisting of diodes D4 through D7. The solid state relay draws no current from the Pressure Alarm. A mechanical relay would draw about 20 mA, which, by itself, would drain the internal battery in about 24 hours. The use of the solid state relay prolongs the battery life of the Pressure Alarm to about 2 week of continuous operation.

Using a DVM (Digital Volt Meter) as an ohmeter or voltmeter will not reveal whether the Remote Alarm output is working in the Normally Open (NO) or the Normally Closed (NC) mode, see figure 28. The Remote Alarm cicruit is basically a FET controlled diode bridge. The FET acts to control current flow through the diode bridge when an external voltage source is present across the bridge, see figures 29 and 30.

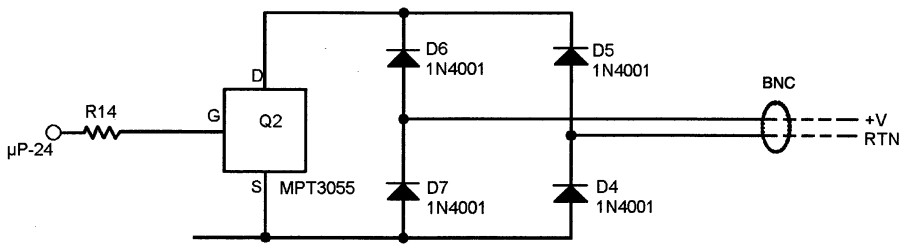


Figure 28 Remote Alarm Circuit

In figure 29, the FET, Q2, is OFF. It is represented by its internal resistance in the OFF state, which is several MegOhms. This large resistance prevents current from flowing through either D5 or D6 if an external voltage is present between the center and return of the BNC cable. D4 and D7 are reversed biased, and will not conduct. This is the Normally Closed condition (an alarm appears as an open circuit).

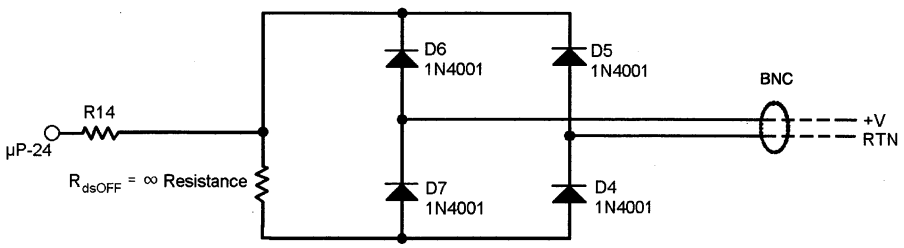


Figure 29 Normally Closed

Alarms and Indicators
Continued

In figure 30, the FET, Q3, is ON. Is is represented by its internal resistance in the ON, state, R_{dsON}, which is approximately 15 milliOhms (0.15 ohms). Q3 appears similar to a piece of wire. Current can flow through D5, Q2, and D7. If the external voltage source is wired backwards, current can flow through D6, Q2 and D4. This is the Normally Open state (an alarm appears as a short-circuit).

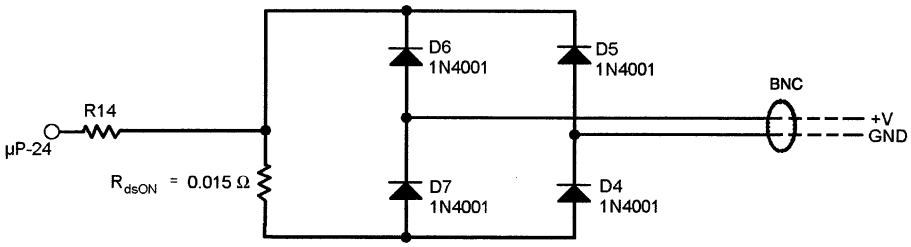


Figure 30 Normally Open

Figure 31 shows how to test NO/NC operation. An external relay, a DVM and a power supply are needed. The power supply could be a battery. A 5-volt, 12-volt, or 24-volt relay can be wired as either NO or NC. Figure 31 shows how to simulate a Hospital Alarm NO/NC system. A power supply is needed to power the relay. Figure 31 shows the relay in the NO mode. The Pressure Alarm should also be configured in the NO mode. When the Pressure Alarm is allowed to alarm, current flows through the coil of the relay, causing it to close. The DVM placed across the relay will read a short circuit, i.e. zero resistance. The relay can also be configured as NC, which would cause the opposite DVM readings to occur, i.e. the DVM will read a open-circuit when an alarm condition occurs.

Please note that both an external power source, a relay and a DVM are needed to test the Remote Alarm output of the Pressure Alarm. The Pressure Alarm allows current to pass through the diode bridge causing the NO/NC relay to change state. The Pressure Alarm output is completely passive, i.e., it supplies no power to the Hospital Alarm system.

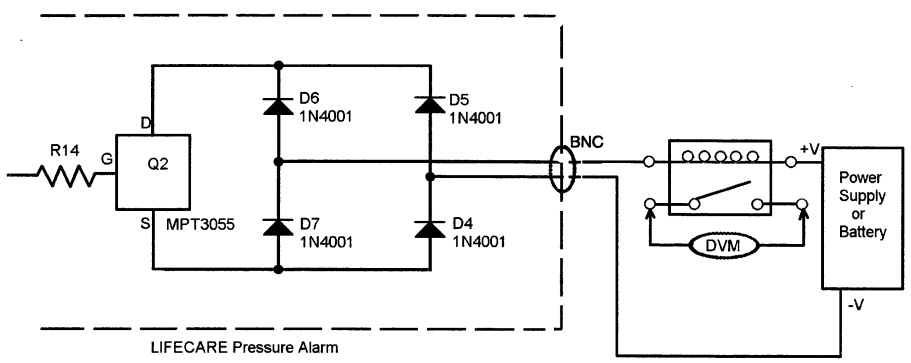


Figure 31 Remote Alarm Output Test Setup

Liquid Crystal Display and Driver

▼ The Pressure Alarm uses a custom liquid crystal display (LCD) driven by an HD61602 LCD driver, U7. The driver connects to the microprocessor through a standard interface and the 125 kHz, E clock from the processor serves directly as the LCD driver's clock input. R29 through R32 and C9 through C11 make up the standard voltage dividing ladder required by the driver. C8 is the bypass capacitor for U7. All LCD control and flashing is controlled by the microprocessor.

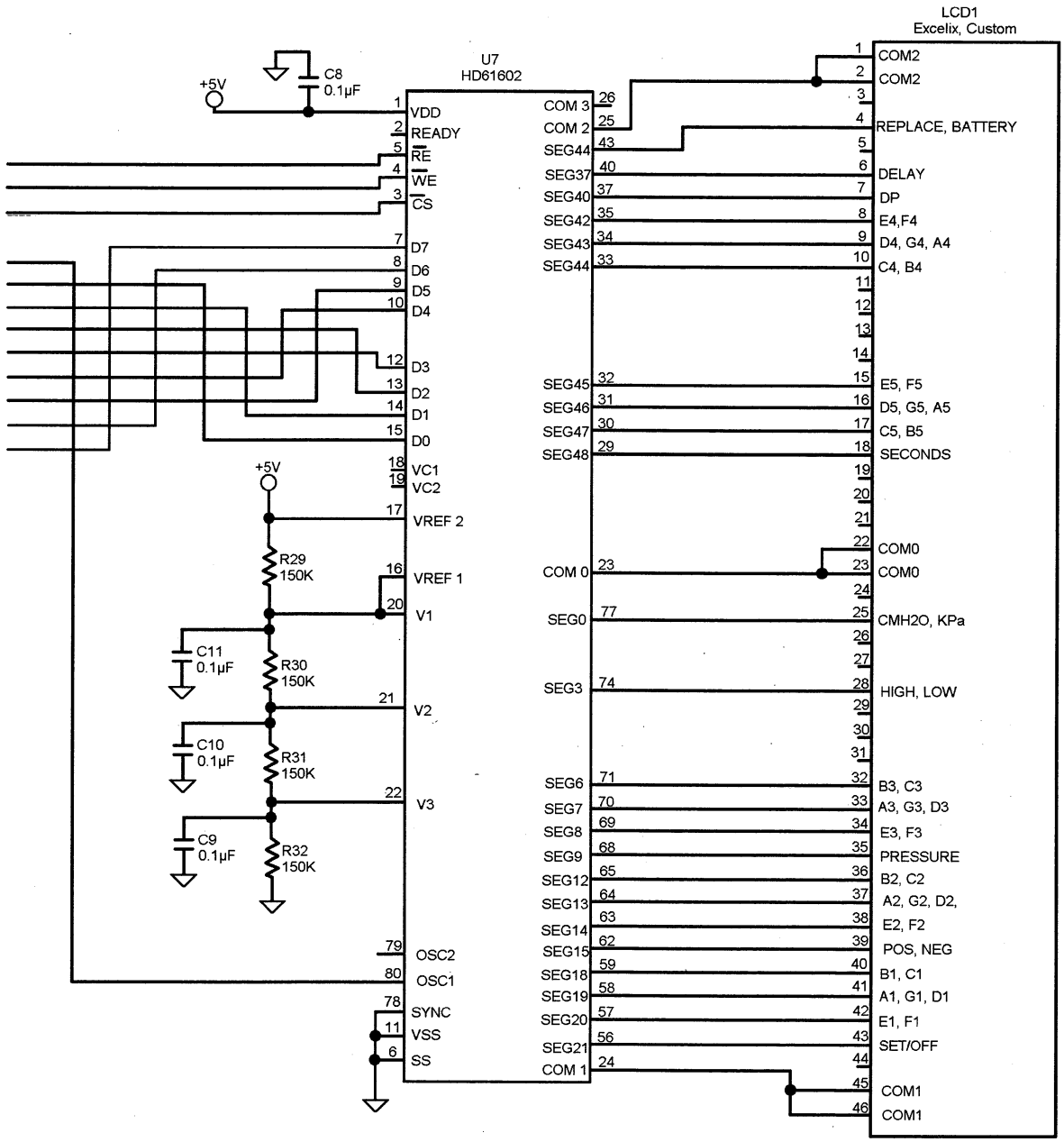


Figure 32 Liquid Crystal Display and Driver

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Calibration and Testing **Section 11.0**

Calibration and Testing

▼ Calibration and Units of Pressure

Caution: Calibration of the Pressure Alarm is not required during normal servicing. It is recommended that the Pressure Alarm be calibrated by an authorized LIFECARE Serve Center once every twelve months. Calibration of the Pressure Alarm requires an accurate pressure source that has both positive pressures up to 100 cm of water and negative pressures to -100 cm (if calibrating for kPa, the source must cover the range -10 to +10 kPa). The accuracy of the pressure source must be better than 0.25 percent at both -100 and +100 cm. Calibrate the unit at normal room temperature while powering it with an external power adapter.

NOTE: If a kPa reading is desired, then the entire procedure requires 10 kPa to be used as the calibration pressure.

1. Hold down both the UP and DOWN Arrow keys, then press the ON/OFF key. The alarm sounds and the word "CAL" is displayed in the window. The unit enters the Run Mode.

2. Apply zero pressure to the unit (removing tubing from the manometer). Hold down the ON/OFF key, then press the ALARM SILENCE key. The alarm sounds. Release the ALARM SILENCE key, then release the ON/OFF key. This provides a reading at zero pressure.

3. Attach tubing to the manometer and apply 100 cm pressure to the unit. Hold down the ON/OFF key, then press the UP arrow key. The alarm sounds. Release the UP arrow key, then release the ON/OFF key. This provides a reading at 100 cm pressure.

4. Apply -100 cm pressure to the unit. Hold down the ON/OFF key, the press the DOWN arrow key. The alarm sounds. Release the DOWN arrow key, the release the ON/OFF key. This provides a reading at -100 cm pressure.

5. Press the ENTER/CHANGE key to enter the Change Settings Mode. Hold down the ALARM SILENCE key and press both the UP arrow key and the ENTER/CHANGE key at the same time. This allows entry into the Calibration routine and "H_2O" is displayed.

NOTE: To change to kPa, press the UP and DOWN arrow keys and the ON/OFF key at the same time, until "PA" is displayed. Press the ENTER/CHANGE key until "CAL" is displayed.

6. Press the ENTER/CHANGE key so "CAL" is displayed. Press the UP and DOWN arrow keys and the ON/OFF key at the same time. One beep of the alarm indicates successful entry of values.

Calibration and Testing
Continued

7. When the unit returns to the Run Mode, press the DOWN arrow key. Apply -95 cm to the manometer. The reading from the Pressure Alarm must be within 2 cm of the manometer reading.

8. Apply +95 cm to the manometer. The reading from the Pressure Alarm must be within 2 cm of the manometer reading. If the reading is 2cm or more from the manometer reading, turn the unit off and repeat steps 1 through 8.

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Parts List **Section 12.0**

Parts List

Component	Facility	U/M	Qty	Ref.
06268	ADPTR, 02 INLET, HUMIDI	EA	1.00	
06686	TUBING, PVC, 3/16"ID, BU	FT	6.00	
21125	OUTLET, NEBULIZER	EA	1.00	
23017	OVERLAY, SWITCH, PRESSU	EA	1.00	
•23018	LCD, PRESSURE ALARM	EA	1.00	LCD1
23019	LABEL, BACK PANEL, PRES	EA	1.00	
23023	CASE, PRESSURE ALARM	EA	1.00	
•23025	PCB, PRESSURE ALARM, B	EA	1.00	
•23028	ALARM, PIEZO, 2.8 KHZ	EA	1.00	PA1
•23029	SPACER, 1/4 OD, #4 ID, 1	EA	2.00	For Buzzer
•23030	SPACER, 1/4" ROUND SWA	EA	5.00	PCB Mounts
23031	WASHER, RECTANGULAR, PR	EA	1.00	
23035	SOFTWARE, PRESSURE ALA	EA		
23037	LABEL, SWITCH, R. ALARM	EA	1.00	
23039	MICROCONTROLLER, PROGR	EA	1.00	
23059	WINDOW, OVERLAY, LCD	EA	1.00	
23500	MANUAL, USER'S, PRESSAL	EA	1.00	
23501	MANUAL, USERS, PRESS AL	EA	1.00	
23510	COVER, MANUAL, OPRTG, PR	EA	1.00	
23511	TEXT, MANUAL, OPRTG, PRE	EA	1.00	
23905	ASSY, PCB, PRESSURE ALA	EA	1.00	
23906	ASSY, FNCTL, PRESSURE A	EA	1.00	
34024	FOOT, RUBBER, 1/2DIA X	EA	2.00	
•34025	SOCKET, QUAD, 52 PIN	EA	1.00	For U4
34026	BATTERY, 9V TRANSISTOR	EA	1.00	
34031	CONVERTER, 120VAC/9VDC	EA	1.00	
34034	GASKET, 0.125", BLACK	EA	1.00	
35155	RETAINING RING	EA	1.00	
35474	FASTENER, DUAL LOCK	EA	2.00	
37042	CONTACT, 0.100 GOLD CRI	EA	5.00	
•37051	XSTR, FET, MTP3O55E, TO2	EA	1.00	Q1
37187	WASHER, FLAT, #4, SST	EA	2.00	
37195	NUT, 4-40 KEP SST	EA	4.00	
38031	WIRE, 22AWG, GRN, UL1	FT	0.30	
38032	WIRE, 22AWG, YEL, UL1	FT	0.30	
38041	WIRE, 22AWG, BLK, UL1061	FT	0.30	
38082	WIRE, 22AWG, BLU, UL1061	FT	0.30	
•38114	CONN/E, FEM, 23 PIN SOC	EA	2.00	For LCD1
38212	CONN/E, MALE, 5 PIN, SIG	EA	1.00	
38239	CONN/E, 5 PIN HOUSING,	EA	1.00	
•38241	CONN/E, 16PIN, DUAL ROW	EA	1.00	J2
•38242	CONN/E, 8-PIN HEADER,	EA	1.00	J3
38243	CONN/E, BNC, BULKHEAD A	EA	1.00	
•38244	SWITCH, DPDT, 100MA, 30V	EA	1.00	SWL
38322	CONN/E, BATTERY 9V	EA	1.00	
38323	CONN/E, DC POWER JACK	EA	1.00	
•39012	RES, 1K OHM, 1/4W, 5%	EA	1.00	R23
39019	SPACER, LED	EA	12.00	
•39020	RES, 1M OHM, 1/4W, 5%	EA	6.00	R2,R8,R15,R16,R20
•39032	DIODE, 1N914, 75MA, 75V	EA	3.00	D1-D3

• Identifies parts located on PCB and lists Reference Designator

Parts List

Component	Facility	U/M	Qty	Ref.
•39034	DIODE, 1N4001, 1A 50V	EA	4.00	D4-D7
•39063	RES, 100 OHM, 1/4W, 5	EA	1.00	R1
•39389	RES, 510 OHM, 1/4W, 5%, C	EA	2.00	R5,R6
•39410	ICL, 555 CMOS TIMER	EA	1.00	U5
•39420	IC/D, 74C906 HEX BUFF	EA	1.00	U2
•39426	RES, 8.2K OHM, 1/4 W, 5%	EA	7.00	R7,R11-R14,R21,R33
•39434	RES, 51K, 1/4W, 5%, CF	EA	2.00	R32,R34
•39448	SENSOR, PRESSURE, MPX10	EA	1.00	PT1
•39449	CAP, 100, UF, 10V, ELEC	EA	1.00	R22
•39450	RES, 510K, 1/4W, 5%,	EA	3.00	R9,R17,R19
•39451	RES, 150K OHM, 1/4W, 5%	EA	8.00	R24-31
•39492	IC/L, MAX663CPA, VOLT.	EA	1.00	U1
•39493	IC/L, MC34164, UNDER VO	EA	1.00	U3
•39551	LED, RED, T1, HLMP-17	EA	3.00	L1,L2,L3
•39552	LED, YELLOW, T1, HLMP	EA	3.00	L4,L5,L6
•39598	CAP, 3.3 UF, 16V, TAN	EA	1.00	C5
•39608	CAP, 0.10UF, 50V, X7R, CE	EA	10.00	C1,C3,C4,C6-C12
•39610	XSTR, 2N7008, N-CHANNEL	EA	1.00	Q2
•39629	IC/D, ICL7621BCPA, DUA	EA	1.00	U6
•39687	IC/D, HD61602, LCD DRIV	EA	1.00	
•39688	IC/D, 68HC811, MICROCON	EA	1.00	U4
•39718	RES, 100K, OHM, 1/4W,	EA	1.00	R10
91149	MANUAL, OPRTG, PRESS AL	RF		
91150	MANUAL, OPRTG, PRESS AL	RF		
98114	CARTON, MONITORS/ALAR	EA	1.00	
98115	CARTON, INS, PRESS/REM	EA	1.00	
98116	CARTON, ACCESSORY, PRES	EA	1.00	
98145	TIE, CABLE, 4", NYLON	EA	1.00	
98174	LABEL, WHITE, 1/2" X 1	EA	1.00	
98187	TUBING, SIL, RUB, 1/8X1/	FT	0.18	
98326	ADHESIVE, LOCTITE #414	EA	1.00	
98333	TAPE, 1/16" THK 1/2",	RL		
98351	SCREW, 4-40X.38, TF, SLO	EA	3.00	
98525	SHRINK TUBE, 1/8DIA, CL	FT	0.30	
98580	PLASTIC BAG, 4 MIL, 6"X	EA	2.00	
98649	LABEL, MEDICAL DEVICE,	EA	1.00	
98824	SCREW, CRPHMS, 4-40X1, P	EA	4.00	
•98842	SCREW, CRPHMS, 4-40X1/2	EA	4.00	
98911	NUT, HEX 3/8-32	EA	1.00	
Selected	RES, 100-500k OHMS, 1/4W, 5	EA	1.00	R18
Selected	RES, APPROX 8.2K OHM, 1/4	EA	1.00	R22

• Identifies parts located on PCB and lists Reference Designator

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Schematics

Section 13.0

Pressure Alarm Schematic
PCB Component Side
PCB Wiring Diagram, Component Side
PCB Solder Side
PCB Wiring Diagram, Solder Side

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Pressure Alarm Schematic

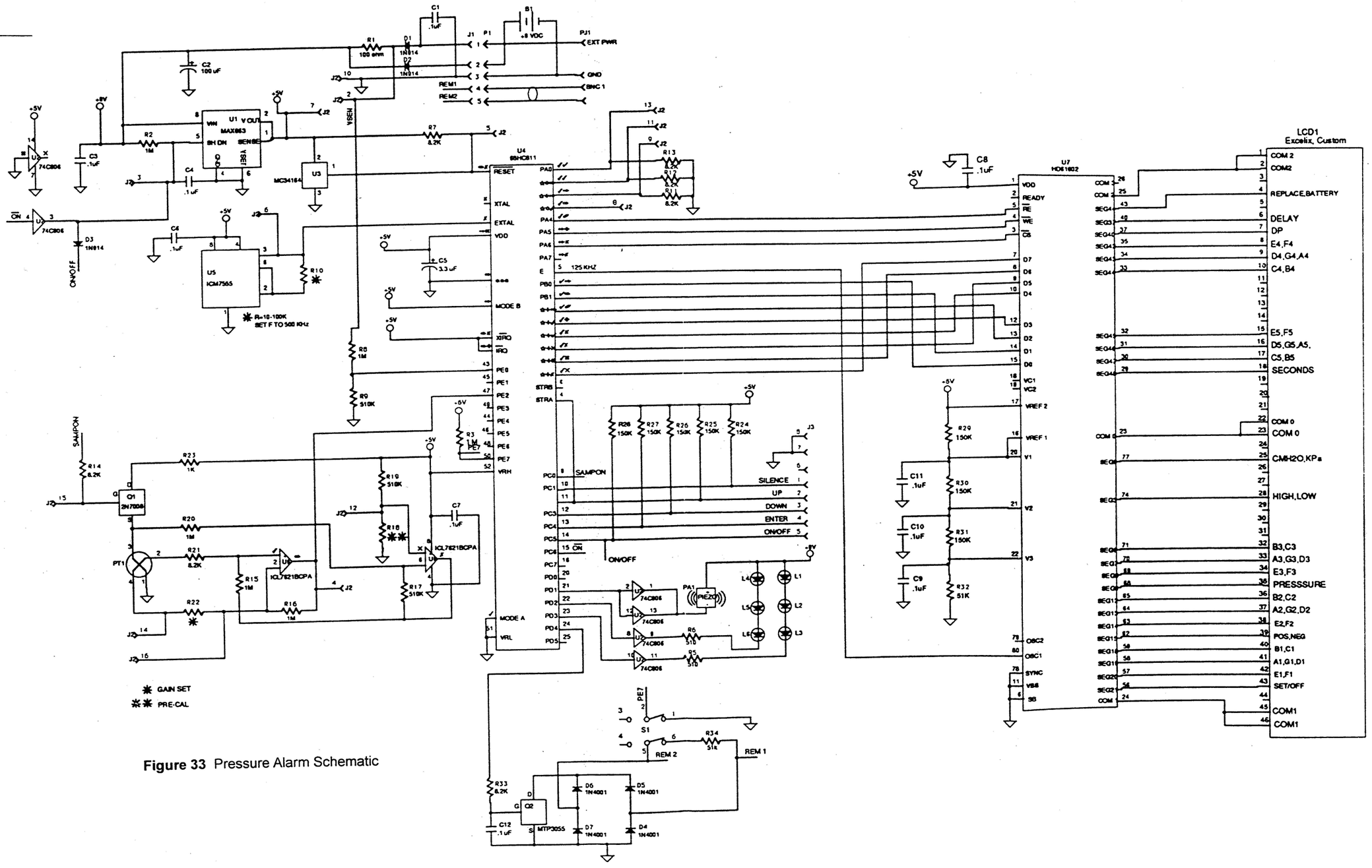

Figure 33 Pressure Alarm Schematic

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Schematics

PCB Component Side

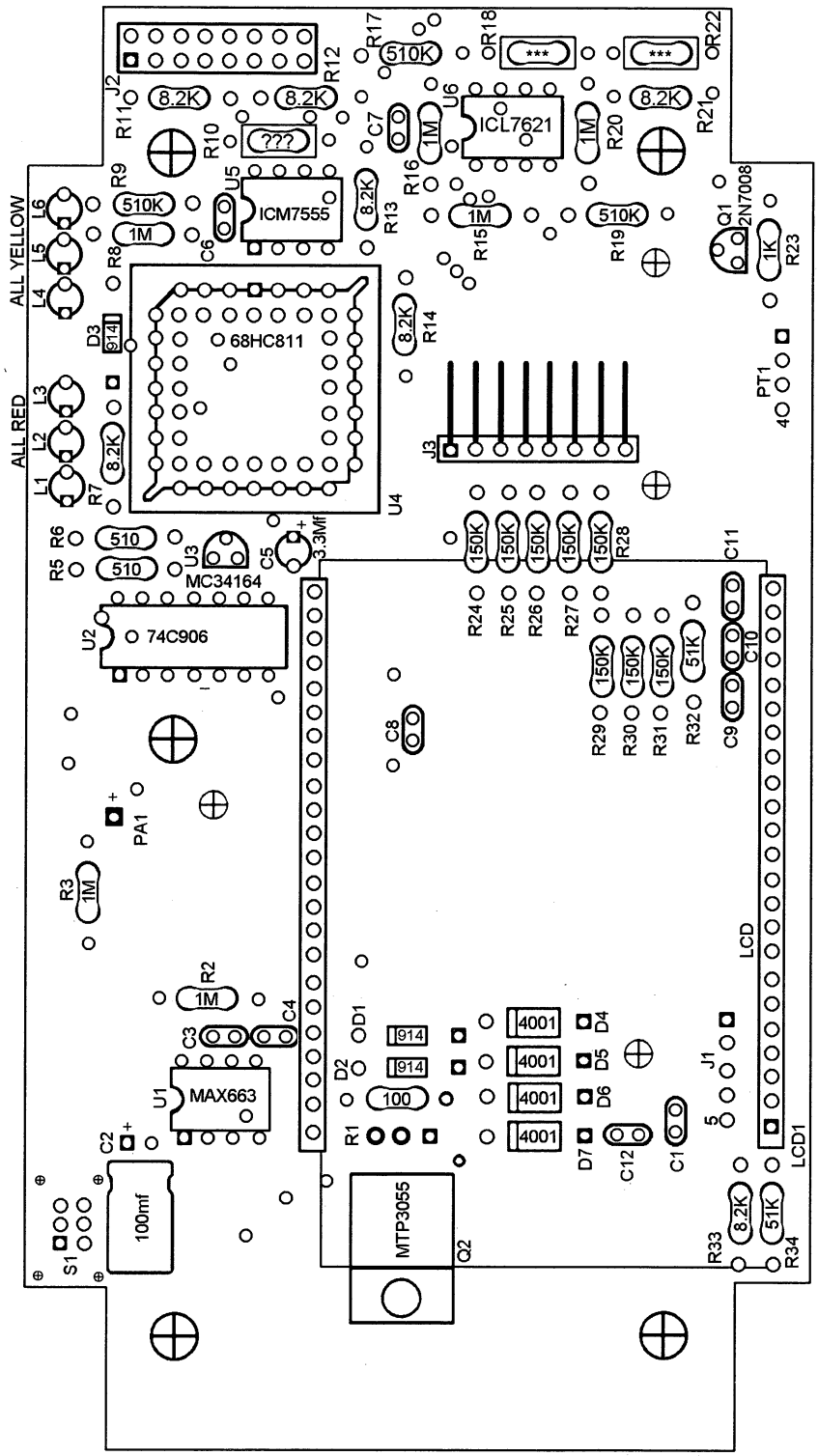

Figure 34 PCB Component Side

PCB Wiring Diagram, Component Side

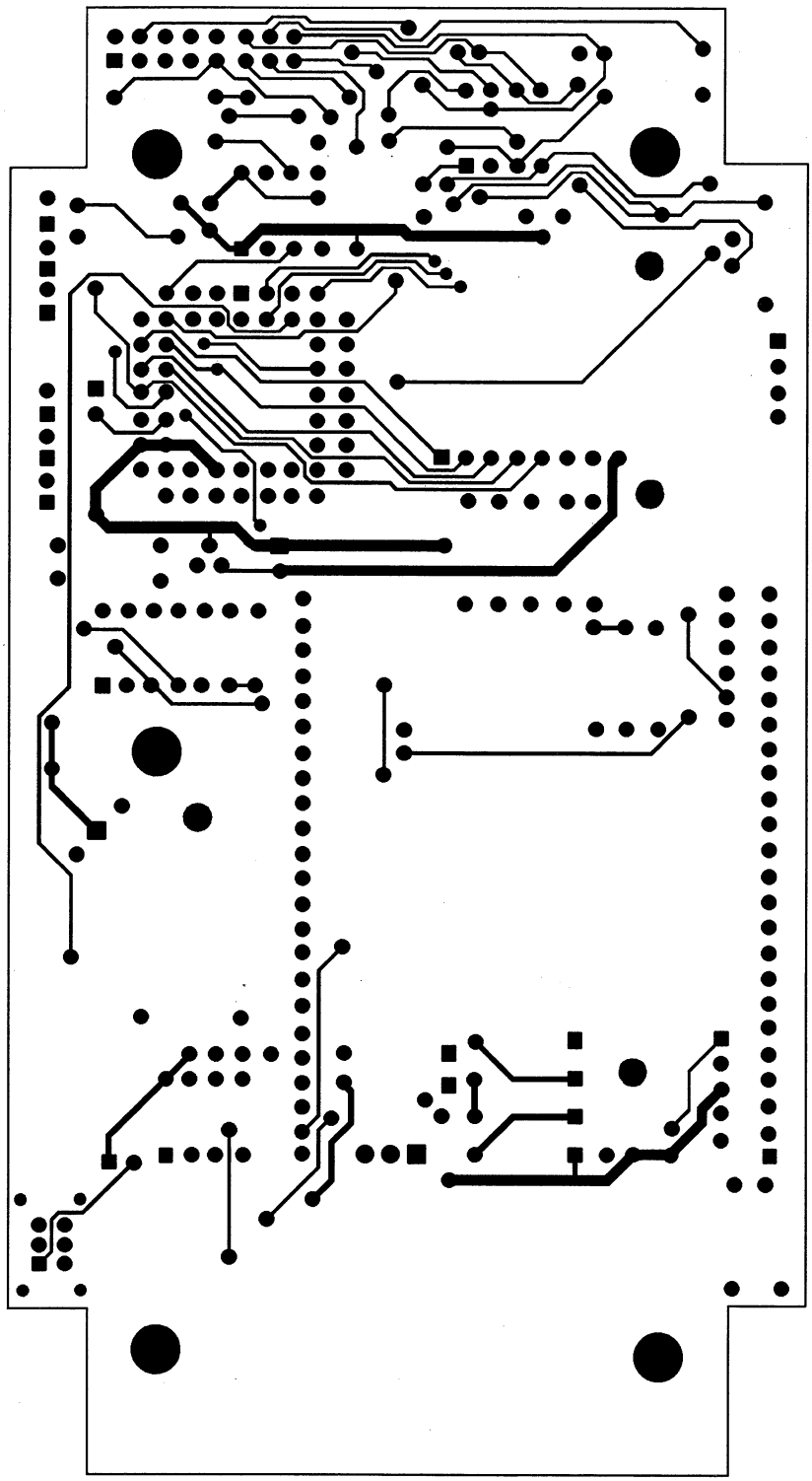

Figure 35 PCB WiringDiagram, Component Side

Schematics

PCB Solder Side

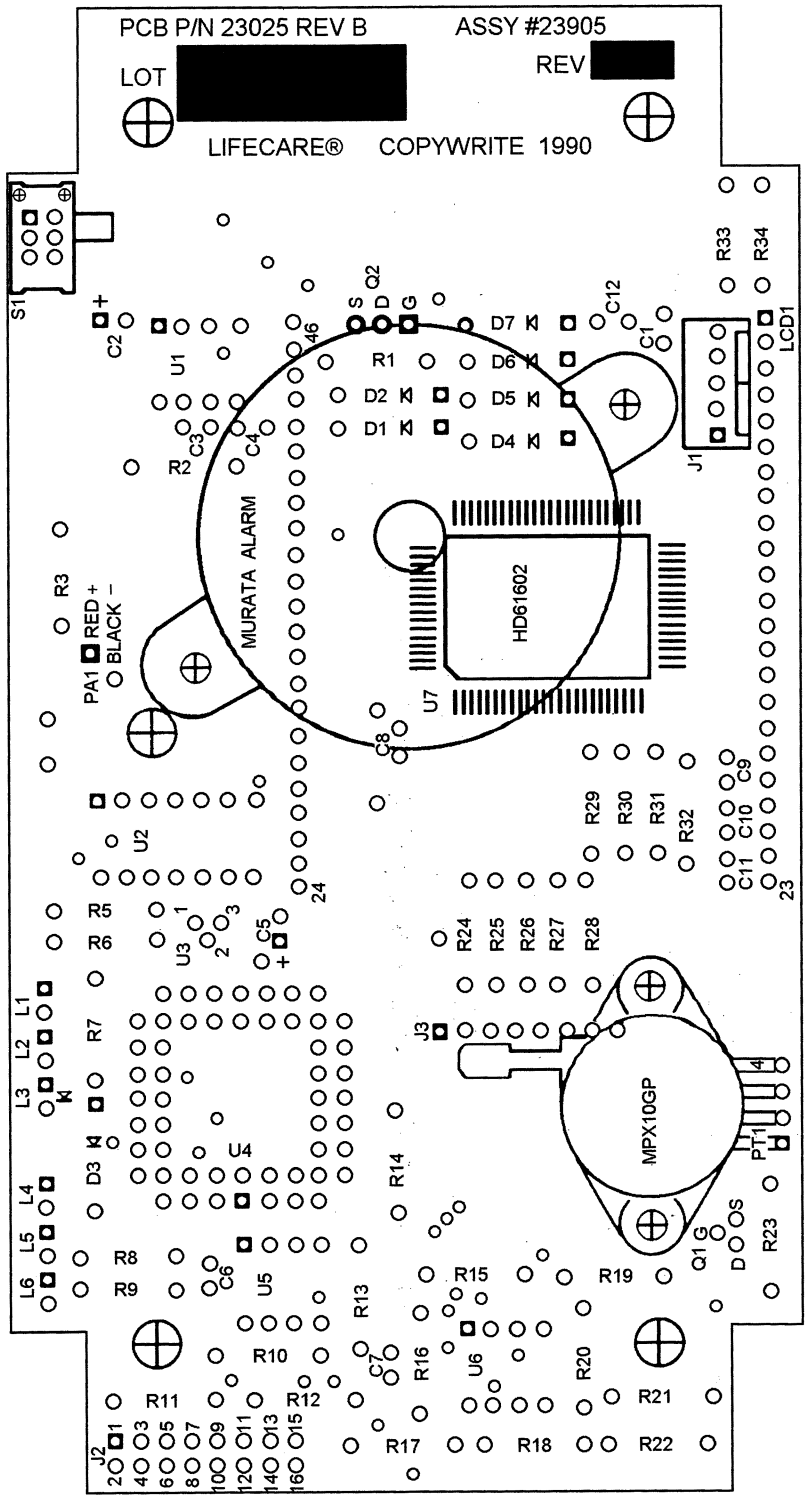

Figure 36 PCB Solder Side

PCB Wiring Diagram, Solder Side

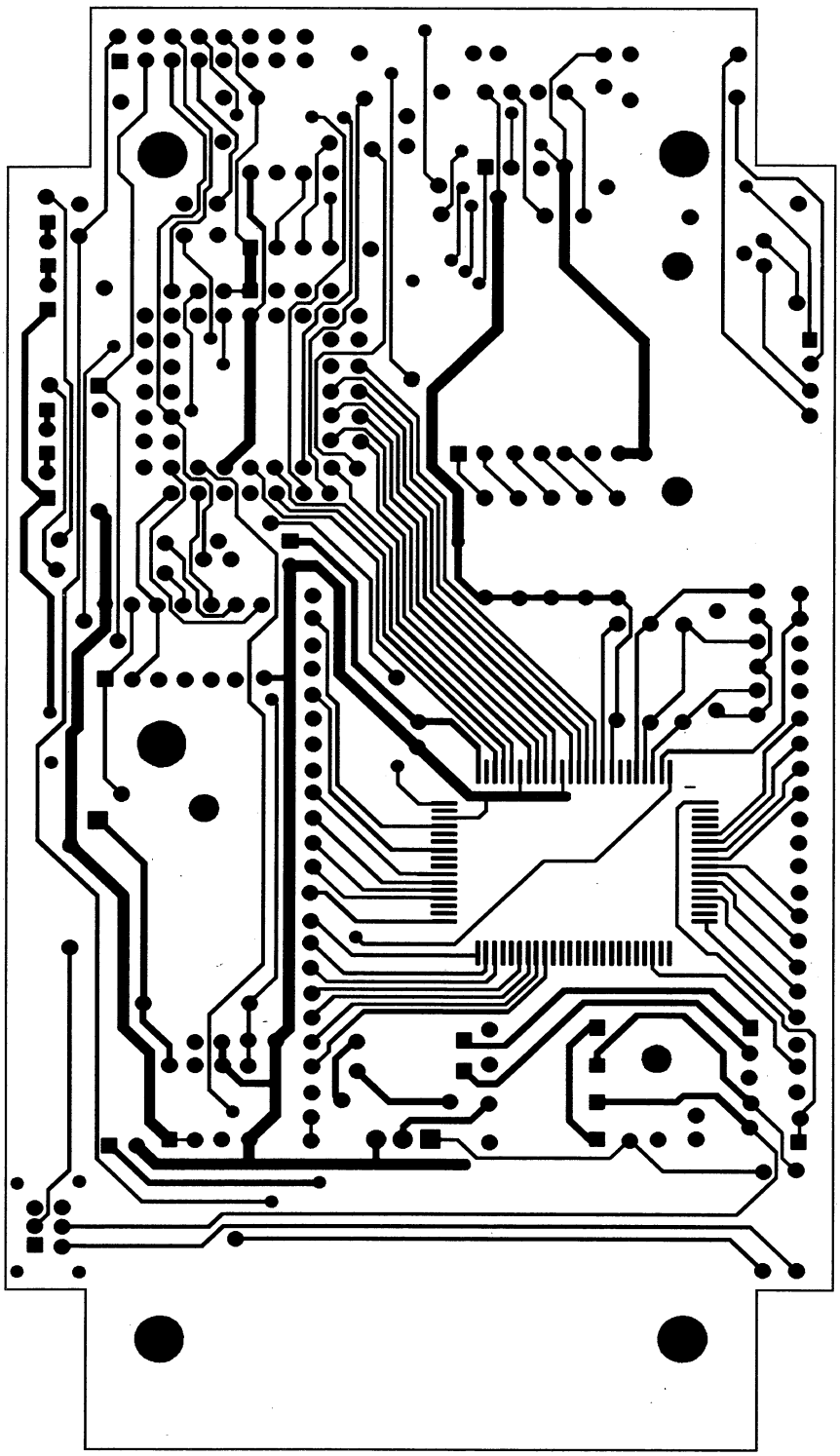

Figure 37 PCB Wiring Diagram, Solder Side

Appendix

Appendix

Standard Accessories
Optional Accessories
Mounting Accessories
Additional Accessories

Accessories

▼ The Pressure Alarm unit adapts to positioning on various systems. Refer to the following descriptions when ordering accessory adapters and for installation procedures. Accessories include individual assembly instructions.

Standard Accessories

06686 3/16" ID Tubing, 6ft.
This connects to all Pressure Alarm Adapters

06232 PAP Adapter
This adapter allows for the use of the Pressure Alarm to positive pressure ventilator circuits. Place pressure line adapter between inspiratory tubing and positive pressure ventilator as shown. Connect a 5-7mm (1/4") ID supply tube from the small hose barb elbow on the pressure line adapter to the pressure alarm unit. Be sure all connections are adequately secure.

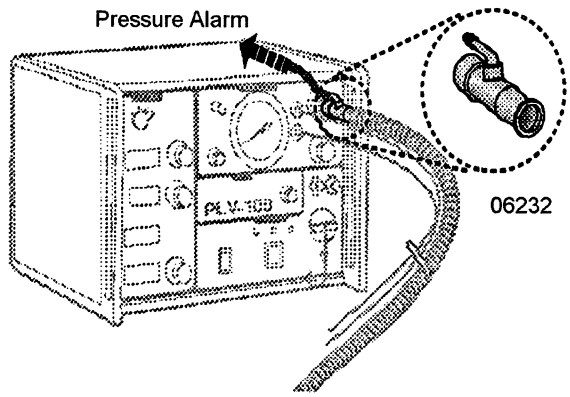

Figure 38 PAP Adapter

34026 Alkaline Battery

34031 120 VAC to 9 VDC Converter
This converter is standard on all domestic units. It is not included with international shipments

23500 Mini-Op Instruction Card
This is printed on plastic

23501 Pressure Alarm Operators Manual

Accessories

Optional Accessories

Negative Pressure Ventilator Adapters

23901 Iron Lung Mount, Complete
This mount allows for the secure fastening of the Pressure Alarm to the Iron Lung. The chrome-plated adapter fits between the Iron Lung chamber and the pressure gauge. There is a fitting for 3/16" tubing and a plastic cap to seal the fitting when the Pressure Alarm is not connected.

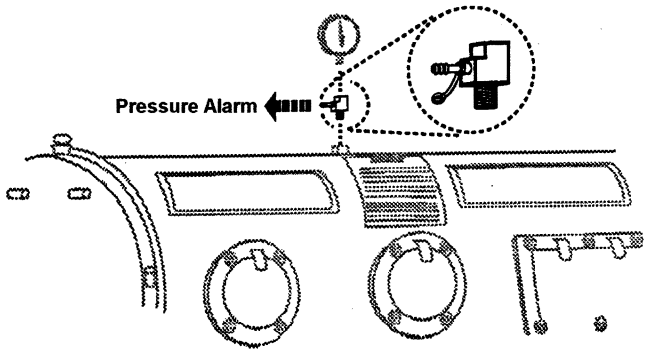

Figure 39 Iron Lung Mount

23903 Portable Ventilator Adapter
This adapter connects at the hose fitting on the side of the Portable Ventilator. Insert small end of adapter into hose socket on the left side of the portable ventilator unit. Screw the gauge into the adapter. Fit tubing onto gauge and attach to inlet on Pressure Alarm

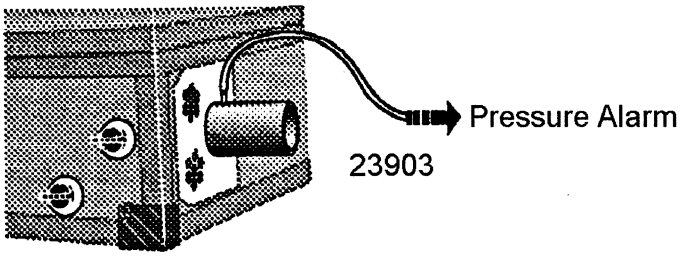

Figure 40 Portable Ventilator Adapter

Optional Accessories
Continues

37723 & 06240 Adapter for 170C
Most users have the 06240 with the need of the 37723 "tee". Insert smaller end of adapter into house socket located on front panel of the 170C unit. Tee must be placed in tubing between gauge and adapter by making a cut in the tubing. Fit the remaining outlet to tubing which leads to Pressure Alarm.

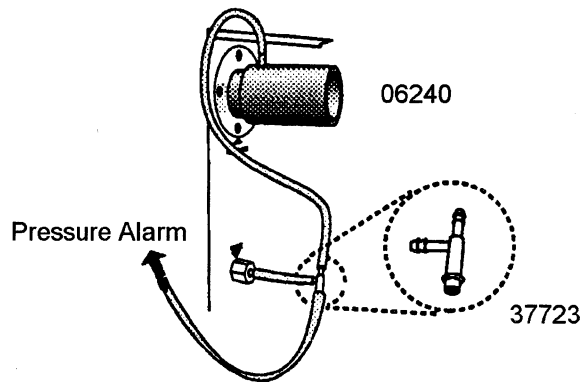

Figure 41 Adapters for 170C

Mounting Accessories

23902 Iron Lung Mounting Kit
This mount secures the Pressure Alarm to the Iron Lung adapter at the top of the Iron Lung under the manometer. The pressure gauge is still visible above the Pressure Alarm. This kit includes the "C" clamp, knob and necessary hardware assembly only. Order if user already has the Ventilator Mount, p/n 27920.

27918 Pole Mount Kit
This mount is used to secure the Pressure Alarm to a range of poles, from our pedestal stand to a circuit support arm (1/4" to 1-5/8" diameter). The mount is easily installed by tightening the screw on the C-clamp until it is securely fastened into place. The pressure alarm unit is attached to the plate mount by positioning the dual lock foot pads into place.

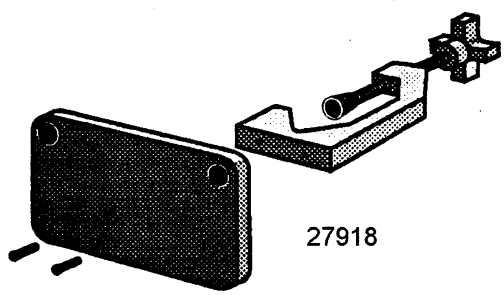

Figure 42 Pole Mount Kit

Additional Accessories
Continued

23020 Negative Inspiratory Force Adapter
This disposable adapter is used to measure negative inspiratory force in the Intensive Care Unit. Insert 15mm OD adapter to base and attach to patient. Connect oxygen tube to open oxygen connector. Adjust liter flow as directed by physician. If the open oxygen stem is not used, use attached plugs to seal stem. Attach a large bore tube to either end. Connect the other end to aerosol or oxygen source.

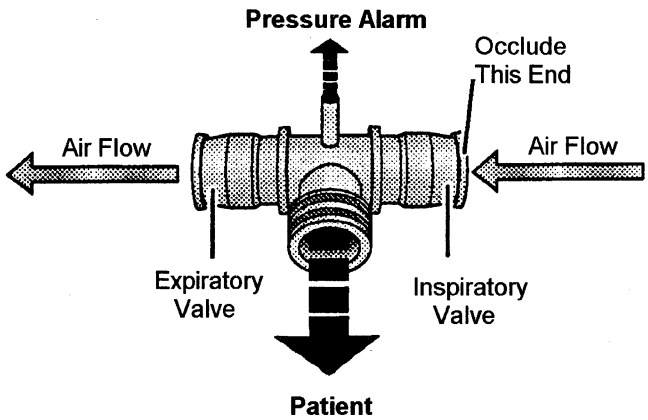

Figure 44 Negative Inspiratory Foce Adapter